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THERMAL CONDUCTIVITY STANDARD REFERENCE

MATERIALS FROM 4 TO 300 K. I. ARMCO IRON

by

J. G. Hust

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THERMAL CONDUCTIVITY STANDARD REFERENCE
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ABSTRACT

Thermal conductivity, electrical resistivity, Lorenz ratio, and thermopower data are reported for several specimens of Armco iron for temperatures from 4 to 300K. At low temperatures the electrical resistivity and thermal conductivity vary from specimen to specimen by more than 10%. However, the Lorenz ratios of these specimens differ by less than 1.5%; and the intrinsic resistivities calculated using Matthiessen's rule differ by less than 0.2% of the total resistivities. Thus, Armco iron specimens can be used as standards by measuring the residual resistivities and utilizing the Lorenz ratio reported here.

KEY WORDS

Cryogenics, electrical resistivity, iron, Lorenz ratio,
Seebeck effect, thermal conductivity, transport properties.

* This work was carried out at the National Bureau of Standards under the sponsorship of the NASA-Space Nuclear Propulsion Office, Cleveland.

1. Introduction

Design and development engineers in the aerospace industry continue to have urgent need for thermal and mechanical property data for new materials. For most materials, especially new or uncommon alloys measured values of thermal conductivity are not available and predictions cannot be made with adequate confidence. To help satisfy these needs, we have constructed an apparatus for the simultaneous measurement of thermal conductivity, electrical resistivity and thermopower. Measurements have been conducted on several aerospace alloys, Hust, et al.^[1] Another phase of this program, to establish standard reference data on several standard reference materials (or specimens), has begun. We intend to measure several specimens of materials which appear to be useful as standards. For some materials, material variability may be so great that only standard specimens (not standard materials) will be useful. Standard reference specimens or materials are useful for intercomparison of existing apparatus, for debugging new apparatus, and for calibration of comparative apparatus. The apparent large differences between the results of various investigators for a given material (50% is not unheard of) is evidence of the need for intercomparisons, calibrations, and standardization. The availability of standard reference materials will result in more accurate and more permanent transport property data for technically important solids.

This paper contains the results of our measurements on the transport properties of Armco iron.* Armco iron was investigated at low temperatures primarily because of its extensive use as a thermal conductivity standard at higher temperatures.^[2]

* The use in this paper of trade names of specific products is essential to the proper understanding of the work presented. Their use in no way implies any approval, endorsement, or recommendations by NBS. Armco iron is a registered trade name of a commercially pure iron produced by Armco Steel Corporation.

2. Apparatus and Data Analysis

The apparatus is based on the axial one-dimensional heat flow method. The specimen is a cylindrical rod 3.6 mm in diameter and 23 cm long with an electric heater at one end and a temperature controlled sink at the other. The specimen is surrounded by glass fiber and a temperature controlled shield. Eight thermocouples are mounted at equally spaced points along the length of the specimen to determine temperature gradients in the range 4 to 300 K.

The experimental data are represented by arbitrary functions over the entire range and smooth tables are generated from these functions. The number of terms used to represent each of the data sets is optimized, through the use of orthonormal functions, so that none of the precision of the data is lost by "underfitting" nor are any necessary oscillations introduced by "overfitting." A detailed description of this apparatus and the methods of data analysis is given by Hust, et al.^[1] Further details are given in the Appendix of this report.

3. Specimen Characterization

An Armco iron rod (2.54 cm diameter and 35.6 cm long) was obtained from Battelle Memorial Institute. Typical composition of Armco iron in weight percent is: 0.015 C, 0.028 Mn, 0.005 P, 0.025 S, 0.003 Si, 0.04 Cu, and 99.9 Fe. This rod was annealed by the supplier as follows: $\frac{1}{2}$ hour at 870°C in a gas-heated air muffle, and then in a quartz capsule at 1×10^{-6} torr for $1\frac{1}{2}$ hours at 875°C, furnace cooled to 150°C, held at 150°C for 24 hours, and furnace cooled to room temperature. We cut the rod into quarters along its axis and cut a 5 cm long piece from each end of each quadrant. These eight pieces were used for electrical residual resistivity ratio, hardness, and grain size measurements. Two of the center 25 cm sections were measured in the thermal conductivity apparatus. The division of the rod and the labeling of specimens is shown in figure 1.

The hardness of these specimens, after machining, was B-40.0. The specimens were subsequently reannealed using the same procedure indicated by the supplier. The hardness after anneal was B-37.1. The grain size approximated from ASTM Chart E112, plate 1 was 0.053 mm and 0.064 mm after machining and after reannealing respectively.

The electrical residual resistivity ratios, RRR, of the eight specimens (1A.... 4A, 1B.... 4B) after machining and of two of these specimens after reannealing are recorded in table 1. These ratios obtained from electrical resistance measurements at 273 K and 4 K in a specially fabricated dip probe, are estimated to be accurate to about 0.2%. Table 1 also contains the resistivity ratios of specimens 2C and 4C. The data marked with asterisks were obtained from the thermal conductivity apparatus.

C. F. Lucks of Battelle Memorial Institute performed similar measurements on another bar of Armco iron.^[3] The rms deviation of his results on six specimens is 6.5% of the mean while the rms deviation of our ten specimens is 3.6%. Lucks made his RRR measurements from 4 K to 298 K; in order to compare absolute values, I adjusted his values to $\rho_{273\text{ K}}/\rho_{4\text{ K}}$ by using $d\rho/dT = 0.05 \mu\Omega\text{cm}/\text{K}$ at the ice point. This value of $d\rho/dT$ comes from my measurements in the thermal conductivity apparatus. The mean value of RRR (13.65) determined from my data is 5.5% below the mean value reported by Lucks. It is noted from table 1 that the RRR values are lower after annealing. This is an unexplained phenomena at this time, but probably is connected with diffusion of impurities from the grain boundaries upon heat treatment.

4. Results

The transport properties of specimens 2C and 4C were measured in the thermal conductivity apparatus. Specimen 2C was subsequently annealed (same annealing procedure as described before) and remeasured. These data are presented in tables 2 through 7. These specimens are referred to as 2 and 4 respectively in these tables. Specimen 2C after annealing is referred to as 2a.

The experimental data were functionally represented with the following equations:

$$\ln \lambda = \sum_{i=1}^n a_i [\ln T]^{i+1} \quad (1)$$

$$\rho = \sum_{i=1}^m b_i [\ln T]^{i+1} \quad (2)$$

$$S = \sum_{i=1}^k c_i [\ln T']^i / T'; T' = \frac{T}{10} + 1 \quad (3)$$

where λ = thermal conductivity, ρ = electrical resistivity, S = thermopower, and T = temperature. Temperatures are based on the IPTS-68 scale above 20 K and the NBS P2-20 (1965) scale below 20 K. The parameters, a_i , b_i , and c_i , determined by least squares, are presented in tables 8, 9, and 10. Further details of this procedure are described by Hust, et al.^[1] The deviations of the experimental data from these equations are given in tables 11 through 19 and in figures 2 through 10. The "observed" thermal conductivities are computed from the mean temperature gradients indicated by adjacent thermocouples. Calculated values of λ , ρ , S , and $L = \rho\lambda/T$ (Lorenz ratio) are presented in tables 20, 21, and 22 and in figures 11, 12, and 13.

A detailed error analysis for these measurements has been presented previously by Hust, et al.^[1] Based on this analysis of systematic and random errors the uncertainty estimates (with 95% confidence) are as follows:

thermal conductivity: 2.5% at 300 K, decreasing as T^4 to 0.70% at 200 K, 0.70% from 200 K to 50 K, increasing inversely with temperature to 1.5% at 4 K.

electrical resistivity: 0.25%

thermopower: 0.5% + 0.2 μ V/K at 4 K, 0.2% + 0.05 μ V/K at 30 K, and 0.1% + 0.03 μ V/K above 76 K.

The thermopower values given here are absolute values although our measurements were carried out with respect to normal silver wire. The absolute thermopowers of normal silver reported by Borelius, et al^[4] were used to convert the experimental data to the absolute scale.

5. Discussion

The thermal conductivities of these specimens differ by as much as 10% at low temperatures; the differences observed in electrical resistivity are similar. The thermal conductivity deviations of the three sets of values are shown in figure 14. These data would suggest that Armco iron is a poor thermal conductivity standard at low temperatures. However, upon further examination it is found that this conclusion is not valid. The Lorenz ratio for these measurements is much less variable at low temperatures than either ρ or λ . Figure 15 illustrates the deviations of the Lorenz ratios for each specimen from the mean value.

Since these deviations are not appreciably larger than the uncertainty in the measured Lorenz ratio, the Lorenz ratio is assumed to be invariant from specimen to specimen. Thus one can obtain the electrical resistivity of a particular specimen of Armco iron and compute the thermal conductivity using the Lorenz ratio reported here.

In order for the above procedure to be practical one needs a relatively quick method of generating a ρ vs T curve for a particular specimen from relatively few measurements. Matthiessen's rule indicates that $\rho = \rho_0 + \rho_i$, where ρ_0 is the residual resistivity of the specimen and ρ_i is the intrinsic resistivity of the material. It is known that this rule is not satisfied exactly and that a correction term $\Delta(\rho_0, \rho_i)$ exists. However, if this correction term is sufficiently small one can reconstruct a sufficiently accurate ρ vs T curve for a given specimen from knowledge of ρ_i and measurement of ρ_0 (only one measurement). To investigate this possibility, ρ_i was computed for each specimen using Matthiessen's rule. The relative deviations of the computed values of ρ_i from the mean of three sets is shown in figure 16. This plot shows that ρ_i values for specimens 2, 2a, and 4, as computed from Matthiessen's rule, differ from the mean by less than 0.3% of the resistivity. This deviation is only slightly larger than the estimated uncertainty of the measurements. It is not unreasonable to assume that this result can be extended to other specimens of Armco iron having similar values of ρ_0 and thus, Armco iron can be a useful low temperature standard reference material. This is especially significant, since Armco iron is already in extensive use as a high temperature standard reference material.^[2] The thermal conductivity, λ , of standard reference specimen of Armco iron can be computed from

$$\lambda = \frac{LT}{\rho} = \frac{LT}{\rho_i + \rho_o} \quad (4)$$

where L and ρ_i are given in table 23 and ρ_o is determined by a relatively simple measurement.

The absolute thermopowers of these three specimens are compared in figure 17. The deviations between specimens are only slightly larger than the uncertainty in the tabulated values; thus no significant difference between specimens can be detected from this property.

6. Acknowledgments

I wish to thank C. F. Lucks of Battelle Memorial Institute for supplying the Armco iron rod and information regarding annealing. R. P. Reed and R. L. Durcholz of this laboratory did the hardness and grain size testing. This measurement program has been carried out under the helpful guidance of R. L. Powell.

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2. R. W. Powell, "Armco Iron as a Thermal Conductivity Standard, Review of Published Data", Progress in International Research on Thermodynamics and Transport Properties (eds. J. F. Masi and D. H. Tsai, Academic Press, New York, 1962), pp. 454-465.
3. C. F. Lucks, Private communication.
4. G. Borelius, W. H. Keesom, C. H. Johansson, and J. O. Linde, "Establishment of an Absolute Scale for the Thermoelectric Force", Proc. Kon. Akad. Amsterdam 35, 10 (1932).

Table 1

Residual resistivity ratio (ρ_{273K} / ρ_{4K}) of Armco iron

<u>Specimen</u>	<u>After machining</u>	<u>After annealing</u>
1A	14.12	
2A	13.81	
3A	14.13	
4A	12.99	
1B	13.81	
2B	14.51	12.88
3B	14.09	
4B	12.77	11.52
2C	13.86, 13.83*	12.58*
4C	12.44, 13.31*	

* These values were determined from measurements using the thermal conductivity apparatus.

The data listed in tables 2 thru 7 are, in part, card images of experimental data as read into the computer for data processing. These data are not clearly labelled. The following is a line by line explanation of tables 2, 4, and 6.

1st line - Data identification.

2nd line - Sample heater voltage (μ V), current (mA), platinum resistance thermometer voltage (μ V), cryogenic bath pressure (mm of Hg), room temperature ($^{\circ}$ C), platinum resistance thermometer current (mA), code indicating type of cryogenic bath (1 = liquid helium, 2 = liquid hydrogen, 3 = liquid nitrogen, 4 = dry ice-alcohol, 5 = ice-water).

3rd line - Thermocouple emfs (μ V).

4th line - Seebeck emf (μ V), specimen current (mA), specimen voltage drop (μ V).

5th line - Thermocouple temperatures (K).

6th line - Heater power (W), reference temperature (K), specimen resistance (Ω).

Table 2. Basic semi-processed temperature gradient data
for Armco iron, specimen 2.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 27AUG68 135PM							
2901060	30.1000	3841.95	92.8	21.0	1.0	3.0	
155.85	192.39	229.93	267.77	305.95	344.43	383.00	422.30
129.98	200.00	52.46					
THERMOCOUPLE TEMPERATURES							
77.251	79.254	81.302	83.354	85.418	87.487	89.555	91.649
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
8.7322-002		68.606		2.6227-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 28AUG68 625 PM							
3856750	40.0000	4687.70	650.0	21.0	1.0	3.0	
292.10	363.46	437.18	511.91	587.84	664.82	742.62	822.12
318.51	200.00	75.26					
THERMOCOUPLE TEMPERATURES							
92.137	95.916	99.790	103.686	107.619	111.577	115.555	119.591
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.5427-001		76.349		3.7630-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 29AUG68 1145AM							
6754900	70.0000	4738.42	653.0	21.0	1.0	3.0	
743.45	992.50	1254.80	1525.50	1804.70	2091.04	2384.58	2686.87
1343.50	200.00	150.26					
THERMOCOUPLE TEMPERATURES							
116.024	128.583	141.579	154.774	168.184	181.757	195.516	209.535
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
4.7284-001		76.811		7.5130-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 100AM							
9614249	99.5800	4780.40	653.0	21.0	1.0	3.0	
1661.95	2251.69	2878.90	3531.45	4208.12	4903.67	5616.50	6353.80
2724.50	200.00	315.78					
THERMOCOUPLE TEMPERATURES							
161.685	189.631	218.693	248.394	278.803	309.855	341.683	374.600
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
9.5739-001		77.192		1.5789-003			

Table 2 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 220PM							
399637	4.1500	-0.00	666.0	21.0	1.0	1.0	
13.25	15.97	18.95	21.87	24.36	27.04	29.63	31.85
-0.03	100.00	11.66					
THERMOCOUPLE TEMPERATURES							
5.010	5.229	5.446	5.650	5.846	6.032	6.206	6.378
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.6585-003		4.073		1.1680-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 330PM							
827760	8.6000	-0.00	666.0	21.0	1.0	1.0	
41.08	50.58	59.93	68.88	76.99	84.86	92.26	99.07
0.13	200.00	23.36					
THERMOCOUPLE TEMPERATURES							
6.992	7.643	8.252	8.820	9.348	9.836	10.286	10.719
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
7.1187-003		4.073		1.1680-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 630PM							
1265000	13.1350	-0.00	653.4	21.0	1.0	1.0	
109.77	125.17	140.09	154.29	167.46	179.87	191.55	202.52
0.51	200.00	23.43					
THERMOCOUPLE TEMPERATURES							
11.336	12.274	13.159	13.990	14.776	15.497	16.169	16.821
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.6616-002		4.054		1.1715-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 710PM							
2182120	22.6700	-0.00	654.0	21.0	1.0	1.0	
216.53	247.33	276.33	303.43	328.52	351.88	373.74	394.64
3.60	200.00	23.77					
THERMOCOUPLE TEMPERATURES							
17.616	19.415	21.096	22.666	24.144	25.509	26.786	28.033
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
4.9469-002		4.055		1.1885-004			

Table 2 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 347PM							
1155030	12.0000	110.75	652.7	21.0	1.0	2.0	
56.30	63.18	70.20	77.29	83.88	90.48	96.96	102.94
1.04	200.00	23.82					
THERMOCOUPLE TEMPERATURES							
23.127	23.540	23.947	24.356	24.753	25.137	25.509	25.873
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.3860-002	19.875			1.1910-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 505PM							
3480880	36.1300	111.85	652.7	21.0	1.0	2.0	
263.95	310.00	356.00	401.20	445.40	489.10	532.40	576.00
47.20	200.00	27.43					
THERMOCOUPLE TEMPERATURES							
35.483	38.257	41.016	43.716	46.360	48.946	51.488	54.051
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.2576-001	19.935			1.3715-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 120PM							
4860190	50.4200	113.10	653.0	20.0	1.0	2.0	
496.40	583.20	673.60	766.45	861.80	960.30	1061.60	1167.10
241.42	200.00	39.59					
THERMOCOUPLE TEMPERATURES							
49.435	54.534	59.758	65.046	70.418	75.879	81.419	87.134
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
2.4505-001	20.003			1.9795-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 430PM							
2335100	24.2510	111.21	654.0	21.0	1.0	2.0	
106.20	131.40	156.53	180.38	203.26	225.37	246.36	266.92
8.19	200.00	24.42					
THERMOCOUPLE TEMPERATURES							
26.074	27.570	29.041	30.461	31.834	33.150	34.397	35.641
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
5.6629-002	19.900			1.2210-004			

Table 2 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 6SEPT68 1130AM

4149800	42.9900	17240.50	631.0	21.0	1.0	4.0
239.86	352.79	468.08	583.74	700.83	818.62	937.37
544.20	200.00	240.24				1057.68

THERMOCOUPLE TEMPERATURES

204.212	209.434	214.746	220.057	225.417	230.792	236.196	241.657
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HEATER POWER	REFERENCE TEMPERATURE	SPECIMEN RESISTANCE
1.7840-001	193.055	1.2012-003

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 7SEPT68 430 PM

6270555	64.9600	17299.40	627.4	22.0	1.0	4.0
733.74	1001.22	1277.22	1556.20	1841.25	2129.90	2422.95
1174.06	100.00	160.62				2722.05

THERMOCOUPLE TEMPERATURES

227.472	239.645	252.132	264.687	277.470	290.357	303.441	316.795
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HEATER POWER	REFERENCE TEMPERATURE	SPECIMEN RESISTANCE
4.0734-001	193.620	1.6062-003

The data listed in tables 2 thru 7 are, in part, card images of experimental data as read into the computer for data processing. These data are not labelled clearly. The following is a line by line explanation of tables 3, 5, and 7.

1st line - Data identification.

2nd line - Platinum resistance thermometer voltage (μ V),
cryogenic bath pressure (mm of Hg), room
temperature ($^{\circ}$ C), platinum resistance ther-
mometer current (mA), code indicating type
of cryogenic bath (1 = liquid helium, 2 = liquid
hydrogen, 3 = liquid nitrogen, 4 = dry ice-
alcohol, 5 = ice-water), specimen current (mA),
specimen voltage (μ V), mean emf of eight
thermocouples (μ V).

3rd line - Reference temperature (K), specimen
resistance (Ω), specimen temperature (K).

Table 3. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 2.

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 840AM						
3242.83	93.20	21.00	1.00	3.00	200.00	35.64 4.77
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
63.027		1.7820-004		63.298		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 930AM						
3243.31	93.20	21.00	1.00	3.00	200.00	35.54 0.79
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
63.031		1.7770-004		63.076		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 26AUG68 950AM						
3773.15	92.80	21.00	1.00	3.00	200.00	44.90 144.01
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
67.971		2.2450-004		75.983		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 28AUG68 930AM						
4689.61	651.60	21.00	1.00	3.00	200.00	57.58 247.16
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
76.367		2.8787-004		89.764		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 29AUG68 110PM						
4737.00	653.00	20.00	1.00	3.00	200.00	77.94 590.44
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
76.798		3.8970-004		108.179		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 29AUG68 600PM						
4813.05	652.50	21.00	1.00	3.00	200.00	124.82 1298.03
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
77.489		6.2410-004		144.310		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 5SEPT68 845PM						
17246.80	631.50	20.00	1.00	4.00	200.00	206.33 167.69
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
193.115		1.0316-003		200.924		
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 6SEPT68 1125PM						
17316.30	628.60	21.00	1.00	4.00	100.00	118.02 569.56
REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		SPECIMEN TEMPERATURE		
<hr/>						
193.782		1.1802-003		220.121		

Table 3 (Cont.)

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 150PM																																																																																																																																																																																																																															
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE																																																																																																																																																																																																																													
-0.00	666.00	21.00	-0.00	1.00	100.00	11.66 11.12																																																																																																																																																																																																																									
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4.073	1.1660-004	4.941																																																																																																																																																																																																																													
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 420PM																																																																																																																																																																																																																															
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE																																																																																																																																																																																																																													
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REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							4.055	1.1670-004	7.440					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 520PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					-0.00	654.00	21.00	-0.00	1.00	200.00	23.37 99.10	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							4.055	1.1685-004	10.762					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 650PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					-0.00	654.00	21.00	-0.00	1.00	200.00	23.48 195.44	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							4.055	1.1740-004	16.463					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 205PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.30	653.00	21.00	1.00	2.00	200.00	23.59 0.27	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.851	1.1795-004	19.866					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 255PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.70	653.00	21.00	1.00	2.00	200.00	23.72 51.78	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.873	1.1860-004	22.883					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 1115AM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					112.74	652.00	20.00	1.00	2.00	200.00	27.63 442.23	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.983	1.3815-004	46.231					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 255PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.86	654.00	20.00	1.00	2.00	200.00	23.78 69.66	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.881	1.1890-004	23.936				
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REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							4.055	1.1685-004	10.762					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 30AUG68 650PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					-0.00	654.00	21.00	-0.00	1.00	200.00	23.48 195.44	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							4.055	1.1740-004	16.463					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 205PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.30	653.00	21.00	1.00	2.00	200.00	23.59 0.27	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.851	1.1795-004	19.866					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 255PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.70	653.00	21.00	1.00	2.00	200.00	23.72 51.78	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.873	1.1860-004	22.883					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 1115AM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					112.74	652.00	20.00	1.00	2.00	200.00	27.63 442.23	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.983	1.3815-004	46.231					ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 255PM							REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE					110.86	654.00	20.00	1.00	2.00	200.00	23.78 69.66	REFERENCE TEMPERATURE SPECIMEN RESISTANCE SPECIMEN TEMPERATURE							19.881	1.1890-004	23.936																																							
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19.881	1.1890-004	23.936																																																																																																																																																																																																																													

Table 4. Basic semi-processed temperature gradient data
for Armco iron, specimen 2a.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 9 MAR 69 900 AM						
3857600	40.0000	4707.44	647.0	24.0	1.0	3.0
176.41	246.46	318.77	392.53	467.41	543.60	620.64
300.24	200.00	70.64				699.16
THERMOCOUPLE TEMPERATURES						
86.123	89.880	93.726	97.617	101.539	105.499	109.478
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		
1.5430-001		76.529		3.5320-004		
<hr/>						
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 1020 AM						
5788935	60.0000	4703.45	648.0	23.0	1.0	3.0
222.71	384.56	555.17	732.56	915.93	1104.85	1298.58
815.92	200.00	95.86				1497.87
THERMOCOUPLE TEMPERATURES						
88.574	97.165	106.066	115.174	124.455	133.888	143.444
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		
3.4734-001		76.493		4.7930-004		
<hr/>						
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 500 PM						
8067000	83.5700	4767.78	648.0	23.0	1.0	3.0
560.81	909.22	1282.68	1675.24	2083.94	2507.94	2946.02
1922.36	200.00	169.05				3399.18
THERMOCOUPLE TEMPERATURES						
106.908	124.653	143.186	162.222	181.652	201.478	221.674
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		
6.7416-001		77.078		8.4525-004		
<hr/>						
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 11 MAR 69 440 PM						
3860100	40.0000	4859.08	667.0	24.0	1.0	3.0
1077.97	1163.31	1251.43	1340.03	1428.79	1518.60	1608.94
432.88	200.00	135.38				1700.87
THERMOCOUPLE TEMPERATURES						
133.833	138.057	142.394	146.730	151.054	155.405	159.763
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE		
1.5440-001		77.907		6.6690-004		

Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 12 MAR 69 1007 AM							
5792200	60.0000	4857.50	667.0	23.0	1.0	3.0	
1134.58	1329.67	1532.21	1738.83	1949.00	2163.80	2382.15	2605.36
1023.47	200.00	165.30					
THERMOCOUPLE TEMPERATURES							
136.524	146.213	156.052	165.979	175.979	186.106	196.320	206.680
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
3.4753-001	77.893			8.2650-004			

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 25 MAR 69 345 PM							
3378470	35.0000	17217.60	630.0	24.0	1.0	4.0	
84.92	160.20	236.41	312.91	389.76	466.91	544.41	622.65
364.64	100.00	110.50					
THERMOCOUPLE TEMPERATURES							
196.796	200.298	203.834	207.374	210.922	214.476	218.037	221.625
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
1.1825-001	192.835			1.1050-003			

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 1200 NOON							
4730400	49.0000	17334.50	628.0	24.0	1.0	4.0	
325.98	476.80	630.52	785.49	941.76	1099.34	1258.45	1419.74
708.45	100.00	129.94					
THERMOCOUPLE TEMPERATURES							
209.087	216.035	223.084	230.162	237.273	244.419	251.611	258.878
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
2.3179-001	193.957			1.2994-003			

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 715 PM							
6446500	66.7800	17323.50	628.0	24.0	1.0	4.0	
393.58	676.56	967.21	1262.70	1562.96	1867.55	2177.29	2492.78
1276.16	100.00	150.84					
THERMOCOUPLE TEMPERATURES							
212.101	225.086	238.326	251.701	265.212	278.865	292.694	306.779
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
4.3050-001	193.851			1.5084-003			

Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 1215 PM

3485400	36.1700	113.35	649.0	23.0	1.0	2.0
121.93	179.47	233.65	285.60	334.52	382.52	429.04
35.68	200.00	28.20				474.74

THERMOCOUPLE TEMPERATURES

27.118	30.535	33.761	36.867	39.815	42.691	45.459	48.185
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HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

1.2607-001	20.016	1.4100-004
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THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 300 PM

5068460	52.5700	115.82	649.0	23.0	1.0	2.0
219.36	324.85	426.15	526.76	627.07	729.72	834.48
175.46	200.00	34.37				943.00

THERMOCOUPLE TEMPERATURES

33.034	39.367	45.427	51.371	57.226	63.110	69.019	75.068
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HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

2.6645-001	20.147	1.7185-004
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THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 520 PM

5634400	58.4200	120.00	649.0	23.0	1.0	2.0
413.50	534.83	660.15	790.32	925.50	1066.90	1213.85
368.80	200.00	44.98				1367.52

THERMOCOUPLE TEMPERATURES

44.888	52.073	59.343	66.746	74.305	82.053	89.959	98.108
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HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

3.2916-001	20.364	2.2490-004
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THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 7 MAR 69 500 PM

2404575	24.9400	4655.48	643.0	24.0	1.0	3.0
39.78	65.57	91.85	118.38	145.02	171.87	198.65
89.71	200.00	53.60				225.74

THERMOCOUPLE TEMPERATURES

78.236	79.648	81.081	82.521	83.965	85.414	86.858	88.310
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HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE

5.9970-002	76.056	2.6800-004
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Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 433PM							
456730	4.7420	-0.00	672.0	24.0	1.0	1.0	
11.55	15.56	19.62	23.72	27.26	31.03	34.60	37.75
0.01	200.00	25.84					
THERMOCOUPLE TEMPERATURES							
4.889	5.207	5.503	5.792	6.061	6.321	6.560	6.793
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
2.1658-003		4.082		1.2920-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 545 PM							
696128	7.2300	-0.00	672.0	24.0	-0.0	1.0	
27.32	35.46	43.27	51.01	57.87	64.80	71.31	77.23
0.10	200.00	25.86					
THERMOCOUPLE TEMPERATURES							
6.045	6.629	7.159	7.668	8.133	8.576	8.983	9.372
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
5.0330-003		4.082		1.2930-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 715 PM							
1151310	11.9600	-0.00	672.0	24.0	-0.0	1.0	
49.97	68.54	85.71	101.86	116.22	130.11	142.94	154.76
0.43	200.00	25.90					
THERMOCOUPLE TEMPERATURES							
7.595	8.816	9.893	10.880	11.763	12.590	13.342	14.053
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
1.3770-002		4.082		1.2950-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 810 PM							
1908125	19.8200	-0.00	672.0	23.0	-0.0	1.0	
100.81	138.67	172.10	202.63	229.38	254.61	277.63	298.90
1.99	200.00	26.03					
THERMOCOUPLE TEMPERATURES							
10.813	13.098	15.061	16.832	18.398	19.857	21.185	22.437
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE			
3.7819-002		4.082		1.3015-004			

Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1045 AM						
2325375	24.1500	-0.00	673.0	24.0	-0.0	1.0
139.30	186.94	228.56	266.27	299.35	330.40	358.83
4.21	200.00	26.18				385.28
THERMOCOUPLE TEMPERATURES						
13.124	15.930	18.345	20.525	22.462	24.271	25.929
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		27.501
5.6158-002		4.083		1.3090-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1200 NOON						
1263105	13.1210	-0.00	673.0	24.0	-0.0	1.0
188.06	200.57	212.93	225.14	236.24	247.37	257.94
0.84	200.00	26.05				267.77
THERMOCOUPLE TEMPERATURES						
15.983	16.723	17.438	18.139	18.796	19.438	20.043
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		20.627
1.6573-002		4.083		1.3025-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 12 MAR 69 540 PM						
1433200	14.8850	110.03	649.0	23.0	1.0	2.0
23.33	35.79	48.24	60.57	72.00	83.41	94.39
1.82	200.00	26.28				104.71
THERMOCOUPLE TEMPERATURES						
21.168	21.904	22.625	23.339	24.018	24.682	25.318
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		25.937
2.1333-002		19.836		1.3140-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 1015 AM						
2022330	21.0000	111.79	649.0	23.0	1.0	2.0
58.57	81.15	103.20	124.72	144.72	164.32	182.98
5.37	200.00	26.58				200.74
THERMOCOUPLE TEMPERATURES						
23.316	24.648	25.938	27.199	28.391	29.549	30.649
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		31.719
4.2469-002		19.932		1.3290-004		

Table 4 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 27 MAR 69 445 PM							
HEATER POWER	REFERENCE TEMPERATURE	SPECIMEN RESISTANCE					
2896500	30.0000	17492.50	624.0	24.0	1.0	4.0	
836.10	894.12	953.57	1012.84	1071.74	1130.78	1190.16	1250.63
263.21	100.00	137.56					
THERMOCOUPLE TEMPERATURES							
233.947	236.585	239.285	241.973	244.641	247.312	249.995	252.724
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
8.6895-002		195.473		1.3756-003			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 3 APRIL 69 430 PM							
HEATER POWER	REFERENCE TEMPERATURE	SPECIMEN RESISTANCE					
2878800	29.8200	25486.20	620.0	23.0	1.0	5.0	
60.32	121.19	182.76	244.43	306.20	368.06	430.24	492.86
245.31	100.00	173.34					
THERMOCOUPLE TEMPERATURES							
275.998	278.715	281.464	284.218	286.975	289.737	292.513	295.309
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
8.5846-002		273.288		1.7334-003			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 4 APRIL 69 920 AM							
HEATER POWER	REFERENCE TEMPERATURE	SPECIMEN RESISTANCE					
2896200	30.0000	25510.00	628.0	23.0	1.0	5.0	
60.90	122.44	184.73	247.11	309.60	372.20	435.15	498.55
247.90	100.00	173.69					
THERMOCOUPLE TEMPERATURES							
276.257	279.005	281.786	284.571	287.361	290.156	292.966	295.797
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE							
8.6886-002		273.523		1.7369-003			

Table 5. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 2a.

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 19 MAR 69 230 PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
-0.00	665.00	24.00	-0.00	1.00	200.00	25.83 0.75
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 12 MAR 69 445 PM						
109.62	649.00	23.00	1.00	2.00	200.00	26.10 0.09
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
19.813	1.3050-004	19.818				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 7 MAR 69 125 PM						
4641.75	643.00	23.00	1.00	3.00	100.00	23.58 0.05
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
75.931	2.3580-004	75.934				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 8 MAR 69 1020 AM						
4702.60	643.00	23.00	1.00	3.00	200.00	54.44 141.37
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
76.485	2.7220-004	84.195				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 11 MAR 69 1055 AM						
4859.10	665.00	24.00	1.00	3.00	200.00	109.88 1034.62
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
77.907	5.4940-004	131.684				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 23 MAR 69 730 PM						
17207.00	632.00	25.00	1.00	4.00	200.00	196.01 0.57
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
192.734	9.8005-004	192.760				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON (2A) 2 APRIL 69 415 PM						
25477.80	624.00	26.00	1.00	5.00	100.00	162.50 0.22
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
273.206	1.6250-003	273.215				

Table 6. Basic semi-processed temperature gradient data
for Armco iron, specimen 4.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68							1140AM
1922030	19.9400	4653.41	644.0	22.0	1.0	3.0	
45.40	62.00	78.90	95.80	112.82	129.86	146.96	164.28
55.32	200.00	52.72					
THERMOCOUPLE TEMPERATURES							
78.525	79.434	80.357	81.276	82.202	83.124	84.052	84.986
HEATER POWER REFERENCE TEMPERATURE							SPECIMEN RESISTANCE
3.8325-002		76.037			2.6360-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68							540PM
3369920	34.9500	4657.94	636.0	23.0	1.0	3.0	
180.11	233.73	288.93	344.72	401.42	458.72	516.92	576.13
218.50	200.00	67.46					
THERMOCOUPLE TEMPERATURES							
85.882	88.762	91.707	94.665	97.655	100.657	103.692	106.759
HEATER POWER REFERENCE TEMPERATURE							SPECIMEN RESISTANCE
1.1778-001		76.078			3.3730-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 12 DEC 68							1130AM
5301325	54.9500	4692.75	636.0	21.0	1.0	3.0	
477.40	622.71	774.73	930.44	1090.42	1253.67	1420.97	1592.19
734.22	200.00	108.19					
THERMOCOUPLE TEMPERATURES							
101.934	109.460	117.232	125.095	133.085	141.150	149.336	157.630
HEATER POWER REFERENCE TEMPERATURE							SPECIMEN RESISTANCE
2.9131-001		76.395			5.4095-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68							915AM
7239100	75.0000	4792.45	653.0	25.0	1.0	3.0	
1467.10	1786.68	2122.80	2467.42	2821.28	3123.34	3554.75	3935.23
1636.76	200.00	223.17					
THERMOCOUPLE TEMPERATURES							
152.379	167.752	183.675	199.786	216.138	232.694	249.537	266.661
HEATER POWER REFERENCE TEMPERATURE							SPECIMEN RESISTANCE
5.4293-001		77.302			1.1159-003		

Table 6 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 13 DEC 68 835PM						
7249400	75.1000	4807.35	665.0	23.0	1.0	3.0
2475.63	2824.80	3191.90	3565.48	3947.07	4335.84	4734.08 5140.98
1597.60	200.00	305.46				
THERMOCOUPLE TEMPERATURES						
200.285	216.414	233.198	250.132	267.304	284.703	302.485 320.650
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE						
5.0443-001	77.437			1.5273-003		

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 19DEC 68 500PM						
4114970	42.6300	17179.60	621.0	22.0	1.0	4.0
227.50	338.91	453.24	568.14	684.31	801.22	919.39 1038.88
534.88	200.00	241.62				
THERMOCOUPLE TEMPERATURES						
203.059	208.216	213.488	218.768	224.090	229.429	234.810 240.238
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE						
1.7542-001	192.471			1.2081-003		

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 20DEC 68 1025AM						
6274450	65.0000	17299.90	621.0	21.0	1.0	4.0
1005.08	1279.67	1565.42	1854.66	2149.00	2446.90	2750.30 3059.00
1149.44	200.00	348.82				
THERMOCOUPLE TEMPERATURES						
239.825	252.247	265.105	278.073	291.214	304.515	318.060 331.843
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE						
4.0784-001	193.625			1.7441-003		

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 20DEC 68 340PM						
5075600	52.5800	17290.80	620.0	21.0	1.0	4.0
630.10	804.70	985.10	1166.90	1351.14	1536.93	1725.25 1916.18
794.32	200.00	290.30				
THERMOCOUPLE TEMPERATURES						
222.654	230.628	238.833	247.070	255.385	263.742	272.191 280.736
HEATER POWER REFERENCE TEMPERATURE SPECIMEN RESISTANCE						
2.6688-001	193.537			1.4515-003		

Table 6 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1135 AM						
404476	4.2000	-0.00	653.0	23.0	-0.0	1.0
17.57	20.46	23.52	26.60	29.29	32.21	35.13
-0.03	200.00	26.06				37.71
THERMOCOUPLE TEMPERATURES						
5.313	5.541	5.760	5.972	6.179	6.379	6.572
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		6.766
1.6988-003		4.053		1.3030-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1225PM						
712355	7.4000	-0.00	654.0	24.0	-0.0	1.0
40.55	48.39	56.02	63.42	70.15	76.91	83.48
0.06	200.00	26.09				89.53
THERMOCOUPLE TEMPERATURES						
6.940	7.482	7.982	8.455	8.901	9.324	9.727
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		10.118
5.2713-003		4.054		1.3045-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 130PM						
1102950	11.4600	-0.00	653.0	24.0	-0.0	1.0
90.17	104.38	117.90	130.75	142.61	154.17	165.30
0.31	200.00	26.14				175.69
THERMOCOUPLE TEMPERATURES						
10.137	11.021	11.835	12.597	13.314	13.991	14.636
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		15.258
1.2640-002		4.053		1.3070-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 505PM						
404467	4.2000	-0.00	654.0	24.0	-0.0	1.0
17.78	20.81	23.93	27.07	29.79	32.76	35.66
-0.02	200.00	26.06				38.19
THERMOCOUPLE TEMPERATURES						
5.330	5.568	5.791	6.007	6.215	6.418	6.609
HEATER POWER	REFERENCE TEMPERATURE			SPECIMEN RESISTANCE		6.800
1.6988-003		4.054		1.3030-004		

Table 6 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 540PM						
1973298	20.5000	-0.00	654.0	23.0	-0.0	1.0
200.92	230.19	257.34	282.63	306.01	328.25	349.51
2.68	200.00	26.44				369.68
THERMOCOUPLE TEMPERATURES						
16.710	18.421	19.993	21.455	22.829	24.124	25.361
HEATER POWER	REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			26.560
4.0453-002		4.054		1.3220-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 600PM						
1973298	20.5000	-0.00	654.0	23.0	-0.0	1.0
201.11	230.50	257.74	283.13	306.70	328.90	350.22
2.72	200.00	26.44				370.46
THERMOCOUPLE TEMPERATURES						
16.721	18.439	20.016	21.484	22.870	24.162	25.403
HEATER POWER	REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			26.606
4.0453-002		4.054		1.3220-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 635PM						
1386400	14.4050	-0.00	654.0	23.0	-0.0	1.0
146.98	164.66	181.48	197.47	212.33	226.66	240.45
0.73	200.00	26.24				253.44
THERMOCOUPLE TEMPERATURES						
13.557	14.608	15.589	16.512	17.389	18.216	19.007
HEATER POWER	REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			19.775
1.9971-002		4.054		1.3120-004		
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68 1140AM						
869115	9.0300	110.56	654.0	23.0	1.0	2.0
32.21	36.70	41.39	46.06	50.39	54.87	59.34
0.49	200.00	26.45				63.47
THERMOCOUPLE TEMPERATURES						
21.713	21.986	22.256	22.522	22.785	23.044	23.297
HEATER POWER	REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			23.551
7.8481-003		19.865		1.3225-004		

Table 6 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68							115PM
1250400	12.9900	110.86	653.0	23.0	1.0	2.0	
62.52	71.51	80.14	88.85	97.15	105.37	113.61	121.38
1.41	200.00	26.60					
THERMOCOUPLE TEMPERATURES							
23.496	24.021	24.535	25.039	25.537	26.017	26.494	26.964
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			
1.6243-002		19.881		1.3300-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68							230PM
2211800	22.9700	111.59	653.0	23.0	1.0	2.0	
129.90	153.78	177.13	199.70	221.34	242.44	263.27	283.47
8.60	200.00	27.30					
THERMOCOUPLE TEMPERATURES							
27.491	28.914	30.295	31.632	32.934	34.192	35.431	36.655
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			
5.0805-002		19.921		1.3650-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 17DEC68							455PM
3816900	39.6100	113.55	653.0	23.0	1.0	2.0	
300.91	359.37	417.23	474.16	530.87	587.49	645.15	703.60
77.53	200.00	32.00					
THERMOCOUPLE TEMPERATURES							
37.794	41.316	44.772	48.148	51.501	54.807	58.139	61.507
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			
1.5119-001		20.027		1.6000-004			
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 18DEC68							1150AM
4648820	48.2200	117.32	653.0	22.0	1.0	2.0	
638.00	724.70	815.35	908.42	1004.10	1102.30	1204.40	1309.75
282.46	200.00	48.53					
THERMOCOUPLE TEMPERATURES							
57.922	62.903	68.026	73.216	78.500	83.843	89.327	94.938
HEATER POWER		REFERENCE TEMPERATURE		SPECIMEN RESISTANCE			
2.2417-001		20.226		2.4265-004			

Table 7. Basic semi-processed isothermal electrical resistivity data for Armco iron, specimen 4.

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 16DEC68 1050AM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
-0.00	653.00	23.00	-0.00	1.00	200.00 26.06 4.28
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 16DEC68 100PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
-0.00	654.50	24.00	-0.00	1.00	200.00 26.10 81.83
4.053	1.3030-004	4.394			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 16DEC68 155PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
-0.00	653.00	24.00	-0.00	1.00	200.00 26.20 183.83
4.053	1.3100-004	15.786			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 16DEC68 700PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
-0.00	654.00	23.00	-0.00	1.00	200.00 26.33 257.60
4.054	1.3165-004	20.069			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 17DEC68 1045AM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
110.22	653.50	23.00	1.00	2.00	200.00 26.32 0.55
19.846	1.3160-004	19.878			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 17DEC68 140PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
111.62	653.00	23.00	1.00	2.00	200.00 26.71 116.83
19.923	1.3555-004	26.745			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 17DEC68 255PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
113.58	653.50	23.00	1.00	2.00	200.00 27.83 269.55
20.028	1.3915-004	35.938			
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 17DEC68 530PM					
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE			
117.54	653.00	23.00	1.00	2.00	200.00 34.06 593.61
20.237	1.7030-004	55.386			

Table 7 (Cont.)

ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 18DEC68 250PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
117.92	653.50	22.00	1.00	2.00	200.00	48.59 978.12
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 10DEC68 620PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
4604.18	630.00	23.00	1.00	3.00	200.00	47.55 2.71
75.589	2.3775-004	75.738				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 11DEC68 143PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
4658.02	636.00	23.00	1.00	3.00	200.00	55.20 151.78
76.079	2.7600-004	84.360				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 11DEC68 1000PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
4689.33	636.00	22.00	1.00	3.00	200.00	69.23 402.76
76.364	3.4615-004	98.003				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 12DEC68 445PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
4766.59	636.00	24.00	1.00	3.00	200.00	127.62 1302.61
77.067	6.3810-004	144.158				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 13DEC68 510PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
4808.22	666.00	24.00	1.00	3.00	200.00	196.50 2293.19
77.005	9.8250-004	191.793				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 19DEC68 145PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
17156.40	621.00	22.00	1.00	4.00	200.00	197.80 19.11
192.249	9.8900-004	193.141				
ISOTHERMAL RESISTIVITY DATA FOR ARMCO IRON(4) 19DEC68 620PM						
REFERENCE TEMPERATURE	SPECIMEN RESISTANCE	SPECIMEN TEMPERATURE				
17290.00	621.00	22.00	1.00	4.00	200.00	260.64 866.01
193.530	1.3032-003	233.013				

Table 8. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 2.

COEFFICIENTS FOR		
THERMAL CONDUCTIVITY	ELECTRICAL RESISTIVITY	THERMOPOWER
4.51614994+000	-4.95025810-007	-3.44881675+002
-4.13926935+000	1.65473929-006	2.37913833+003
2.07599685+000	-2.37099406-006	-6.68364762+003
-8.61606749-001	1.93668635-006	9.99411766+003
3.39315321-001	-9.93191337-007	-8.67747098+003
-9.99896812-002	3.51399468-007	4.46376537+003
1.79360964-002	-7.18946352-008	-1.32173829+003
-1.71155124-003	9.77121499-009	2.08103179+002
6.66070951-005	-7.54546890-010	-1.35462989+001
	2.52377946-011	

Table 9. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 2a.

COEFFICIENTS FOR		
THERMAL CONDUCTIVITY	ELECTRICAL RESISTIVITY	THERMOPOWER
7.43890940+000	-4.20510751-007	-5.10933863+002
-1.14675555+001	1.45081937-006	3.36812410+003
9.73124560+000	-2.12826875-006	-9.06609424+003
-5.28250471+000	1.77366602-006	1.30552541+004
1.89245802+000	-9.25249389-007	-1.09917641+004
-4.41102771-001	3.13228379-007	5.52800895+003
6.37975455-002	-6.87884712-008	-1.61455399+003
-5.17020759-003	9.44600166-009	2.52389423+002
1.78835874-004	-7.35822503-010	-1.63749922+001
	2.47951038-011	

Table 10. Parameters in eqs. 1, 2, and 3 for Armco iron, specimen 4.

COEFFICIENTS FOR		
THERMAL CONDUCTIVITY	ELECTRICAL RESISTIVITY	THERMOPOWER
8.21226100+000	-5.03088441-007	-6.42943864+002
-1.32577224+001	1.69059561-006	4.14540857+003
1.14738701+001	-2.42733181-006	-1.09289158+004
-6.21776147+000	1.98402296-006	1.54381788+004
2.19527810+000	-1.01722578-006	-1.27838650+004
-5.01619108-001	3.39158569-007	6.34295244+003
7.10720281-002	-7.35034919-008	-1.83456286+003
-5.64940725-003	9.97927431-009	2.84809534+002
1.91995267-004	-7.69854134-010	-1.83820643+001
	2.57278514-011	

These parameters are listed in E format. This format is illustrated by the following example: 1.788-004 = 1.788×10^{-4}

Table 11 Thermal conductivity deviations for Armco iron, specimen 2.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 28AUG68 625 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
94.026	3.779	9.86+001	9.88+001	-0.2	
97.853	3.874	9.59+001	9.73+001	-1.5	
101.738	3.896	9.55+001	9.60+001	-0.5	
105.653	3.933	9.45+001	9.47+001	-0.2	
109.598	3.958	9.41+001	9.35+001	0.6	
113.566	3.978	9.36+001	9.24+001	1.3	
117.573	4.036	9.24+001	9.14+001	1.1	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 29AUG68 1145AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
122.304	12.559	9.09+001	9.03+001	0.7	
135.081	12.996	8.76+001	8.79+001	-0.2	
148.177	13.194	8.64+001	8.60+001	0.5	
161.479	13.410	8.49+001	8.46+001	0.4	
174.970	13.572	8.41+001	8.35+001	0.7	
188.636	13.759	8.29+001	8.25+001	0.5	
202.525	14.020	8.15+001	8.16+001	-0.2	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 100AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
175.658	27.946	8.27+001	8.34+001	-0.9	
204.162	29.062	7.94+001	8.15+001	-2.7	
233.544	29.701	7.77+001	7.95+001	-2.3	
263.598	30.409	7.58+001	7.72+001	-1.9	
294.329	31.053	7.44+001	7.47+001	-0.4	
325.769	31.827	7.26+001	7.23+001	0.3	
358.141	32.917	7.03+001	7.06+001	-0.5	

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 220PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
5.119	0.219	1.83+001	1.80+001	1.7
5.338	0.217	1.84+001	1.89+001	-2.7
5.548	0.204	1.96+001	1.98+001	-1.0
5.748	0.196	2.04+001	2.06+001	-1.3
5.939	0.186	2.15+001	2.14+001	0.4
6.119	0.173	2.31+001	2.21+001	4.2
6.292	0.172	2.32+001	2.28+001	1.8

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 330PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
7.317	0.651	2.64+001	2.67+001	-1.2
7.947	0.610	2.81+001	2.91+001	-3.3
8.536	0.568	3.02+001	3.12+001	-3.1
9.084	0.528	3.25+001	3.31+001	-2.1
9.592	0.488	3.52+001	3.50+001	0.8
10.061	0.449	3.82+001	3.66+001	4.2
10.502	0.433	3.98+001	3.82+001	3.9

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 630PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
11.805	0.938	4.27+001	4.28+001	-0.2
12.717	0.885	4.52+001	4.61+001	-1.9
13.575	0.831	4.82+001	4.92+001	-2.0
14.383	0.786	5.09+001	5.21+001	-2.3
15.136	0.721	5.56+001	5.48+001	1.5
15.833	0.672	5.96+001	5.73+001	3.9
16.495	0.652	6.16+001	5.97+001	3.2

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 30AUG68 710PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
18.516	1.798	6.64+001	6.67+001	-0.5
20.255	1.681	7.09+001	7.26+001	-2.4
21.881	1.570	7.60+001	7.78+001	-2.4
23.405	1.478	8.06+001	8.24+001	-2.3
24.826	1.365	8.75+001	8.65+001	1.2
26.147	1.277	9.35+001	9.00+001	3.7
27.409	1.247	9.59+001	9.32+001	2.8

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 347PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
23.334	0.413	8.10+001	8.22+001	-1.6
23.744	0.407	8.21+001	8.34+001	-1.6
24.151	0.409	8.18+001	8.46+001	-3.5
24.554	0.397	8.41+001	8.57+001	-2.0
24.945	0.384	8.72+001	8.68+001	0.4
25.323	0.373	8.98+001	8.78+001	2.1
25.691	0.364	9.20+001	8.88+001	3.4

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 3SEPT68 505PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
36.870	2.774	1.09+002	1.10+002	-0.9
39.637	2.758	1.10+002	1.12+002	-2.2
42.366	2.700	1.12+002	1.14+002	-1.6
45.038	2.645	1.15+002	1.15+002	-0.6
47.653	2.586	1.17+002	1.16+002	1.3
50.217	2.542	1.19+002	1.16+002	2.8
52.769	2.563	1.19+002	1.16+002	2.3

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 120PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
51.984	5.099	1.16+002	1.16+002	0.1
57.146	5.224	1.13+002	1.15+002	-1.7
62.402	5.288	1.12+002	1.13+002	-1.2
67.732	5.372	1.10+002	1.11+002	-0.8
73.149	5.461	1.08+002	1.08+002	0.1
78.649	5.539	1.07+002	1.06+002	1.1
84.276	5.715	1.04+002	1.03+002	0.6

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 4SEPT68 430PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
26.822	1.496	9.14+001	9.17+001	-0.4
28.305	1.470	9.28+001	9.53+001	-2.7
29.751	1.421	9.61+001	9.84+001	-2.4
31.148	1.373	9.93+001	1.01+002	-1.8
32.492	1.316	1.04+002	1.04+002	0.4
33.774	1.247	1.10+002	1.06+002	3.7
35.019	1.244	1.10+002	1.07+002	2.4

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 27AUG68 135PM

MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
78.252	2.003	1.05+002	1.06+002	-0.5
80.278	2.048	1.03+002	1.05+002	-2.0
82.328	2.053	1.03+002	1.04+002	-1.2
84.386	2.064	1.02+002	1.03+002	-1.0
86.452	2.069	1.02+002	1.02+002	-0.1
88.521	2.068	1.02+002	1.01+002	0.8
90.602	2.094	1.01+002	1.00+002	0.6

Table 11 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 6SEPT68 1130AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
206.823	5.222	8.25+001	8.13+001	1.4	
212.090	5.312	8.09+001	8.10+001	-0.1	
217.401	5.311	8.10+001	8.07+001	0.4	
222.737	5.359	8.02+001	8.03+001	-0.2	
228.104	5.375	8.01+001	7.99+001	0.2	
233.494	5.404	7.97+001	7.95+001	0.1	
238.926	5.461	7.89+001	7.91+001	-0.3	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2) 7SEPT68 430 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
233.559	12.173	8.08+001	7.95+001	1.6	
245.889	12.487	7.86+001	7.86+001	-0.1	
258.409	12.554	7.82+001	7.77+001	0.8	
271.078	12.783	7.67+001	7.66+001	0.1	
283.913	12.887	7.63+001	7.56+001	1.0	
296.899	13.084	7.51+001	7.45+001	0.8	
310.118	13.354	7.37+001	7.35+001	0.3	

Table 12 Electrical resistivity deviations for Armco iron, specimen 2.

MEAN TEMPERATURE	TEMPERATURE RANGE	OBSERVED RESISTANCE	CALCULATED RESISTANCE	PERCENT DEVIATION	INTRINSIC RESISTANCE
5.729	1.368	1.166-004	1.166-004	-0.03	2.034-009
9.006	3.727	1.168-004	1.168-004	-0.02	2.020-007
14.277	5.485	1.171-004	1.171-004	0.04	5.520-007
23.205	10.416	1.188-004	1.189-004	-0.01	2.252-006
24.534	2.746	1.191-004	1.192-004	-0.07	2.502-006
44.935	18.568	1.372-004	1.370-004	0.10	2.055-005
67.905	37.699	1.980-004	1.983-004	-0.16	8.135-005
31.044	9.567	1.221-004	1.222-004	-0.12	5.502-006
84.402	14.398	2.623-004	2.624-004	-0.05	1.457-004
105.715	27.454	3.763-004	3.763-004	-0.01	2.597-004
161.880	93.511	7.513-004	7.510-004	0.03	6.347-004
265.025	212.914	1.579-003	1.580-003	-0.08	1.462-003
222.796	37.445	1.201-003	1.202-003	-0.03	1.085-003
271.407	89.322	1.606-003	1.604-003	0.12	1.490-003
4.941	0.000	1.166-004	1.166-004	0.01	2.034-009
7.040	0.000	1.167-004	1.166-004	0.07	1.020-007
10.762	0.000	1.168-004	1.170-004	-0.12	2.520-007
16.463	0.000	1.174-004	1.173-004	0.13	8.020-007
19.866	0.000	1.179-004	1.179-004	0.08	1.352-006
22.883	0.000	1.186-004	1.186-004	-0.04	2.002-006
46.231	0.000	1.381-004	1.379-004	0.20	2.955-005
23.936	0.000	1.189-004	1.190-004	-0.07	2.302-006
63.298	0.000	1.782-004	1.783-004	-0.04	6.160-005
63.076	0.000	1.777-004	1.776-004	0.07	6.110-005
75.983	0.000	2.245-004	2.245-004	-0.00	1.079-004
89.764	0.000	2.879-004	2.880-004	-0.06	1.713-004
108.179	0.000	3.897-004	3.895-004	0.04	2.731-004
144.310	0.000	6.241-004	6.231-004	0.16	5.075-004
200.924	0.000	1.032-003	1.033-003	-0.14	9.151-004
220.121	0.000	1.180-003	1.180-003	0.01	1.064-003

Table 13 Thermovoltage deviations for Armco iron, specimen 2.

UPPER TEMPERATURE	LOWER TEMPERATURE	OBSERVED THERMOVOLTAGE	CALCULATED THERMOVOLTAGE	DEVIATION
6.378	5.010	-0.03	-0.03	0.01
10.719	6.992	0.15	0.18	-0.04
16.821	11.336	0.51	0.40	0.11
28.033	17.616	3.60	3.71	-0.11
25.873	23.127	1.04	1.15	-0.11
54.051	35.483	47.20	46.99	0.21
87.134	49.435	241.42	241.65	-0.23
35.641	26.074	8.19	8.15	0.04
91.649	77.251	129.98	129.81	0.17
119.591	92.157	318.51	318.18	0.33
209.535	116.024	1343.50	1343.64	-0.15
374.600	161.685	2724.50	2724.48	0.02
241.657	204.212	544.20	543.87	0.33
316.795	227.472	1174.06	1174.17	-0.11

Table 14 Thermal conductivity deviations for Armco iron, specimen 2a.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 9 MAR 69 900 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
88.001	3.756	9.92+001	9.91+001	0.1	
91.803	3.846	9.66+001	9.77+001	-1.1	
95.671	3.891	9.56+001	9.64+001	-0.8	
99.578	3.922	9.47+001	9.52+001	-0.5	
103.519	3.960	9.41+001	9.41+001	0.0	
107.488	3.979	9.36+001	9.30+001	0.6	
111.490	4.025	9.26+001	9.20+001	0.7	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 1020 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
92.869	8.591	9.76+001	9.74+001	0.2	
101.615	8.902	9.40+001	9.46+001	-0.6	
110.620	9.108	9.20+001	9.22+001	-0.2	
119.815	9.281	9.01+001	9.01+001	0.0	
129.171	9.433	8.89+001	8.84+001	0.5	
138.666	9.556	8.77+001	8.70+001	0.8	
148.300	9.712	8.64+001	8.59+001	0.6	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 10 MAR 69 500 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
115.780	17.746	9.17+001	9.10+001	0.8	
133.920	18.533	8.76+001	8.77+001	-0.1	
152.704	19.036	8.54+001	8.54+001	0.0	
171.957	19.430	8.36+001	8.36+001	-0.1	
191.565	19.826	8.21+001	8.21+001	0.0	
211.576	20.196	8.05+001	8.05+001	0.0	
231.993	20.639	7.89+001	7.89+001	0.1	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 11 MAR 69 440 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
135.945	4.224	8.83+001	8.74+001	1.0	
140.226	4.337	8.58+001	8.68+001	-1.3	
144.562	4.336	8.59+001	8.63+001	-0.5	
148.892	4.323	8.60+001	8.58+001	0.2	
153.229	4.351	8.57+001	8.53+001	0.4	
157.584	4.359	8.55+001	8.49+001	0.7	
161.969	4.411	8.46+001	8.45+001	0.1	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 12 MAR 69 1007 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
141.419	9.589	8.75+001	8.67+001	0.9	
151.133	9.839	8.51+001	8.56+001	-0.6	
161.016	9.927	8.44+001	8.46+001	-0.2	
170.979	10.000	8.37+001	8.37+001	0.0	
181.042	10.127	8.28+001	8.29+001	-0.1	
191.213	10.214	8.21+001	8.21+001	0.0	
201.500	10.359	8.11+001	8.13+001	-0.3	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 25 MAR 69 345 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
198.547	3.502	8.15+001	8.15+001	-0.0	
202.066	3.536	8.06+001	8.13+001	-0.9	
205.604	3.541	8.05+001	8.10+001	-0.6	
209.148	3.548	8.03+001	8.07+001	-0.6	
212.699	3.553	8.03+001	8.08+001	-0.1	
216.257	3.561	8.01+001	8.01+001	0.0	
219.831	3.587	7.96+001	7.99+001	-0.3	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 12 MAR 69 540 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
21.536	0.736	7.00+001	7.02+001	-0.4	
22.265	0.722	7.12+001	7.23+001	-1.5	
22.982	0.713	7.21+001	7.44+001	-3.1	
23.678	0.679	7.57+001	7.63+001	-0.8	
24.350	0.665	7.75+001	7.81+001	-0.8	
25.000	0.636	8.09+001	7.98+001	1.4	
25.628	0.619	8.33+001	8.14+001	2.3	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 1015 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
23.982	1.332	7.70+001	7.71+001	-0.1	
25.293	1.290	7.93+001	8.05+001	-1.5	
26.569	1.261	8.12+001	8.37+001	-3.0	
27.795	1.192	8.58+001	8.65+001	-0.8	
28.970	1.158	8.86+001	8.91+001	-0.6	
30.099	1.100	9.31+001	9.14+001	1.9	
31.184	1.070	9.59+001	9.34+001	2.6	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 1215 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
28.826	3.418	8.91+001	8.88+001	0.3	
32.148	3.226	9.41+001	9.52+001	-1.1	
35.314	3.106	9.79+001	1.00+002	-2.2	
38.341	2.948	1.03+002	1.04+002	-0.6	
41.253	2.875	1.06+002	1.06+002	-0.3	
44.075	2.769	1.10+002	1.08+002	1.7	
46.822	2.725	1.12+002	1.09+002	2.4	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 300 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
36.201	6.333	1.02+002	1.01+002	0.4	
42.397	6.060	1.06+002	1.07+002	-1.0	
48.399	5.943	1.08+002	1.10+002	-1.3	
54.298	5.855	1.10+002	1.10+002	-0.4	
60.168	5.885	1.09+002	1.09+002	0.2	
66.065	5.909	1.09+002	1.07+002	1.3	
72.043	6.049	1.06+002	1.05+002	1.1	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 13 MAR 69 520 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
48.480	7.184	1.11+002	1.10+002	0.9	
55.708	7.270	1.09+002	1.10+002	-0.7	
63.045	7.403	1.07+002	1.08+002	-1.0	
70.526	7.558	1.05+002	1.06+002	-0.9	
78.179	7.748	1.03+002	1.03+002	-0.3	
86.006	7.907	1.00+002	9.98+001	0.6	
94.033	8.148	9.76+001	9.70+001	0.6	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 7 MAR 69 500 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
78.942	1.412	1.05+002	1.05+002	0.0	
80.364	1.433	1.01+002	1.02+002	-1.2	
81.801	1.440	1.00+002	1.01+002	-1.0	
83.243	1.444	1.00+002	1.01+002	-0.8	
84.690	1.448	9.99+001	1.00+002	-0.4	
86.136	1.444	1.00+002	9.98+001	0.4	
87.584	1.452	9.98+001	9.92+001	0.5	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 433PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
5.048	0.317	1.65+001	1.63+001	1.1	
5.355	0.296	1.76+001	1.74+001	0.9	
5.647	0.289	1.81+001	1.85+001	-2.1	
5.926	0.269	1.94+001	1.95+001	-0.5	
6.191	0.261	2.01+001	2.04+001	-1.8	
6.441	0.239	2.19+001	2.13+001	2.8	
6.677	0.233	2.24+001	2.21+001	1.5	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 545 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
6.337	0.584	2.08+001	2.09+001	-0.5	
6.894	0.530	2.29+001	2.28+001	0.2	
7.413	0.509	2.39+001	2.46+001	-3.1	
7.900	0.465	2.61+001	2.62+001	-0.7	
8.355	0.444	2.74+001	2.77+001	-1.3	
8.780	0.407	2.99+001	2.91+001	2.4	
9.178	0.389	3.12+001	3.05+001	2.5	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 715 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
8.206	1.220	2.72+001	2.72+001	0.0	
9.355	1.078	3.08+001	3.10+001	-0.9	
10.386	0.986	3.37+001	3.44+001	-2.3	
11.321	0.883	3.75+001	3.75+001	0.1	
12.176	0.827	4.02+001	4.03+001	-0.3	
12.966	0.753	4.41+001	4.29+001	2.7	
13.698	0.711	4.68+001	4.54+001	3.1	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 19 MAR 69 810 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
11.955	2.286	3.99+001	3.96+001	0.9	
14.080	1.963	4.64+001	4.66+001	-0.5	
15.947	1.771	5.15+001	5.28+001	-2.4	
17.615	1.565	5.82+001	5.81+001	0.1	
19.127	1.459	6.26+001	6.29+001	-0.6	
20.521	1.328	6.87+001	6.72+001	2.2	
21.811	1.252	7.30+001	7.10+001	2.7	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1045 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
14.527	2.806	4.83+001	4.81+001	0.5	
17.137	2.415	5.60+001	5.66+001	-1.1	
19.435	2.180	6.21+001	6.39+001	-2.8	
21.494	1.937	6.98+001	7.01+001	-0.4	
23.366	1.809	7.50+001	7.54+001	-0.6	
25.100	1.659	8.17+001	8.00+001	2.0	
26.715	1.571	8.63+001	8.40+001	2.7	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 20 MAR 69 1200 NOON					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
16.353	0.740	5.41+001	5.41+001	0.0	
17.080	0.715	5.58+001	5.64+001	-1.1	
17.789	0.701	5.70+001	5.87+001	-3.0	
18.468	0.657	6.08+001	6.09+001	-0.2	
19.117	0.641	6.24+001	6.29+001	-0.8	
19.740	0.605	6.61+001	6.48+001	1.9	
20.335	0.585	6.85+001	6.66+001	2.7	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 1200 NOON					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
212.561	6.947	8.06+001	8.04+001	0.1	
219.559	7.049	7.92+001	7.99+001	-0.8	
226.623	7.078	7.90+001	7.93+001	-0.4	
233.717	7.111	7.85+0.1	7.87+001	-0.3	
240.846	7.146	7.83+001	7.81+001	0.2	
248.015	7.192	7.78+001	7.76+001	0.3	
255.244	7.267	7.71+001	7.70+001	0.1	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 26 MAR 69 715 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
218.594	12.985	8.00+001	8.00+001	0.1	
231.706	13.240	7.83+001	7.89+001	-0.7	
245.013	13.375	7.76+001	7.78+001	-0.2	
258.456	13.512	7.67+001	7.67+001	0.0	
272.039	13.653	7.61+001	7.58+001	0.4	
285.779	13.829	7.51+001	7.50+001	0.2	
299.737	14.086	7.38+001	7.45+001	-0.8	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 27 MAR 69 445 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
235.266	2.638	7.95+001	7.86+001	1.2	
237.935	2.700	7.75+001	7.84+001	-1.1	
240.629	2.688	7.80+001	7.82+001	-0.2	
243.307	2.668	7.84+001	7.79+001	0.6	
245.976	2.671	7.85+001	7.77+001	1.0	
248.654	2.683	7.81+001	7.75+001	0.8	
251.360	2.729	7.69+001	7.73+001	-0.5	

Table 14 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 3 APRIL 69 430 PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
277.356	2.718	7.63+001	7.55+001	1.1	
280.090	2.749	7.52+001	7.53+001	-0.1	
282.841	2.753	7.52+001	7.51+001	0.1	
285.596	2.758	7.50+001	7.50+001	-0.1	
288.356	2.762	7.50+001	7.49+001	0.2	
291.125	2.776	7.46+001	7.48+001	-0.2	
293.911	2.796	7.42+001	7.46+001	-0.6	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(2A) 4 APRIL 69 920 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
277.631	2.748	7.63+001	7.54+001	1.2	
280.395	2.781	7.53+001	7.53+001	-0.0	
283.178	2.785	7.52+001	7.51+001	0.1	
285.966	2.790	7.50+001	7.50+001	0.0	
288.758	2.795	7.50+001	7.49+001	0.2	
291.561	2.811	7.46+001	7.47+001	-0.2	
294.382	2.831	7.42+001	7.46+001	-0.6	

Table 15 Electrical resistivity deviations for Armco iron, specimen 2a.

MEAN TEMPERATURE	TEMPERATURE RANGE	OBSERVED RESISTANCE	CALCULATED RESISTANCE	PERCENT DEVIATION	INTRINSIC RESISTANCE
5.898	1.904	1.292-004	1.292-004	-0.00	5.572-008
7.837	3.327	1.293-004	1.293-004	0.02	1.557-007
11.158	6.458	1.295-004	1.296-004	-0.05	3.557-007
17.293	11.624	1.301-004	1.301-004	0.03	1.006-006
21.110	14.377	1.309-004	1.309-004	-0.04	1.756-006
18.412	4.644	1.302-004	1.302-004	0.07	1.106-006
23.634	4.770	1.314-004	1.315-004	-0.07	2.256-006
27.699	8.402	1.329-004	1.330-004	-0.11	3.756-006
38.111	21.067	1.410-004	1.409-004	0.05	1.186-005
54.224	42.033	1.719-004	1.716-004	0.12	4.271-005
70.853	53.219	2.249-004	2.249-004	0.01	9.576-005
83.251	10.074	2.680-004	2.682-004	-0.08	1.389-004
99.650	27.379	3.532-004	3.534-004	-0.05	2.241-004
120.150	64.582	4.793-004	4.793-004	-0.01	3.502-004
172.780	135.405	8.452-004	8.446-004	0.07	7.161-004
148.915	30.341	6.669-004	6.664-004	0.07	5.378-004
171.185	70.055	8.265-004	8.260-004	0.06	6.974-004
209.164	24.828	1.105-003	1.106-003	-0.10	9.759-004
233.794	49.790	1.299-003	1.299-003	0.03	1.170-003
258.759	94.678	1.508-003	1.508-003	0.01	1.379-003
243.303	18.777	1.376-003	1.374-003	0.11	1.246-003
285.611	19.312	1.733-003	1.734-003	-0.04	1.604-003
285.981	19.540	1.737-003	1.737-003	-0.03	1.608-003
4.132	0.000	1.291-004	1.292-004	-0.00	5.721-009
19.818	0.000	1.305-004	1.304-004	0.06	1.356-006
75.934	0.000	2.358-004	2.358-004	-0.01	1.067-004
84.195	0.000	2.722-004	2.724-004	-0.06	1.431-004
131.684	0.000	5.494-004	5.489-004	0.09	4.203-004
192.760	0.000	9.801-004	9.820-004	-0.20	8.509-004
273.215	0.000	1.625-003	1.624-003	0.04	1.496-003

Table 16 Thermovoltage deviations for Armco iron, specimen 2a.

UPPER TEMPERATURE	LOWER TEMPERATURE	OBSERVED THERMOVOLTAGE	CALCULATED THERMOVOLTAGE	DEVIATION
6.793	4.889	0.01	-0.13	0.14
9.372	6.045	0.10	0.24	-0.14
14.053	7.595	0.43	0.48	-0.05
22.437	10.813	1.99	1.84	0.15
27.501	13.124	4.21	4.21	0.00
20.627	15.983	0.84	0.88	-0.04
25.937	21.168	1.82	1.99	-0.17
31.719	23.316	5.37	5.59	-0.22
48.185	27.118	35.68	35.66	0.02
75.068	33.034	175.46	175.26	0.20
98.108	44.888	368.80	369.03	-0.23
88.310	78.236	89.71	89.65	0.06
113.503	86.123	300.24	300.21	0.03
153.156	88.574	815.92	815.81	0.11
242.313	106.908	1922.36	1922.21	0.15
164.175	133.833	432.88	433.24	-0.36
206.680	136.624	1023.47	1023.63	-0.16
221.625	196.796	364.64	364.50	0.14
258.878	209.087	708.45	708.36	0.09
306.779	212.101	1276.16	1276.24	-0.08
252.724	233.947	263.21	263.59	-0.38
295.309	275.998	245.31	245.17	0.14
295.797	276.257	247.90	247.79	0.11

Table 17 Thermal conductivity deviations for Armco iron, specimen 4.

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68		1100AM		
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
78.980	0.909	1.02+002	1.02+002	-0.1
79.895	0.923	1.01+002	1.02+002	-1.2
80.816	0.919	1.01+002	1.01+002	-0.3
81.739	0.926	1.00+002	1.01+002	-0.6
82.663	0.923	1.01+002	1.01+002	0.3
83.588	0.928	1.00+002	1.00+002	-0.0
84.519	0.934	9.96+001	1.00+002	-0.4
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 11DEC68		540PM		
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
87.322	2.880	9.89+001	9.89+001	-0.0
90.234	2.946	9.68+001	9.78+001	-1.1
93.186	2.957	9.66+001	9.68+001	-0.2
96.160	2.990	9.56+001	9.58+001	-0.2
99.156	3.002	9.54+001	9.49+001	0.6
102.174	3.035	9.42+001	9.39+001	0.3
105.226	3.067	9.32+001	9.31+001	0.1
THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 12 DEC 68		1130AM		
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
105.697	7.526	9.36+001	9.29+001	0.7
113.346	7.772	9.07+001	9.10+001	-0.3
121.163	7.863	8.98+001	8.94+001	0.5
129.090	7.990	8.85+001	8.80+001	0.5
137.118	8.065	8.78+001	8.69+001	1.1
145.243	8.186	8.64+001	8.59+001	0.6
153.483	8.294	8.52+001	8.51+001	0.2

Table 17 (Cont.)

				13 DEC 68	915AM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
160.065	15.373	8.54+001	8.45+001		1.0
175.714	15.923	8.25+001	8.34+001		-1.0
191.731	16.111	8.17+001	8.23+001		-0.8
207.962	16.352	8.06+001	8.12+001		-0.8
224.416	16.556	7.97+001	8.00+001		-0.4
241.116	16.843	7.83+001	7.87+001		-0.5
258.099	17.124	7.69+001	7.72+001		-0.3

				13 DEC 68	835PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
208.349	16.131	8.16+001	8.12+001		0.5
224.806	16.785	7.85+001	8.00+001		-1.9
241.665	16.934	7.80+001	7.86+001		-0.8
258.718	17.172	7.69+001	7.71+001		-0.2
276.003	17.399	7.61+001	7.56+001		0.6
293.594	17.782	7.44+001	7.42+001		0.2
311.567	18.165	7.27+001	7.31+001		-0.5

				19DEC 68	500PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
205.638	5.156	8.23+001	8.14+001		1.0
210.852	5.272	8.05+001	8.10+001		-0.6
216.128	5.280	8.06+001	8.07+001		-0.1
221.429	5.321	8.00+001	8.03+001		-0.3
226.759	5.339	7.99+001	7.98+001		0.0
232.120	5.381	7.92+001	7.94+001		-0.3
237.524	5.427	7.84+001	7.90+001		-0.7

Table 17 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1135 AM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
5.427	0.228	1.80+001	1.76+001	2.4	
5.650	0.219	1.88+001	1.84+001	2.1	
5.866	0.212	1.94+001	1.91+001	1.5	
6.075	0.207	1.99+001	1.99+001	0.4	
6.279	0.200	2.07+001	2.06+001	0.5	
6.475	0.193	2.14+001	2.12+001	0.7	
6.669	0.194	2.12+001	2.19+001	-3.0	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 1225PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
7.211	0.542	2.35+001	2.37+001	-0.7	
7.732	0.501	2.55+001	2.54+001	0.2	
8.219	0.473	2.70+001	2.70+001	0.0	
8.678	0.446	2.87+001	2.85+001	0.6	
9.113	0.423	3.03+001	3.00+001	1.0	
9.526	0.403	3.18+001	3.13+001	1.4	
9.922	0.391	3.27+001	3.26+001	0.4	

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4) 16 DEC 68 130PM					
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION	
10.579	0.884	3.46+001	3.48+001	-0.6	
11.428	0.815	3.76+001	3.76+001	0.0	
12.216	0.761	4.03+001	4.01+001	0.3	
12.955	0.717	4.28+001	4.26+001	0.5	
13.653	0.677	4.54+001	4.49+001	1.1	
14.314	0.645	4.76+001	4.70+001	1.2	
14.947	0.622	4.93+001	4.91+001	0.5	

Table 17 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)			16 DEC 68	505PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
5.449	0.238	1.73+001	1.77+001	-2.3
5.679	0.223	1.85+001	1.85+001	-0.2
5.899	0.216	1.91+001	1.93+001	-0.9
6.111	0.209	1.98+001	2.00+001	-1.1
6.317	0.203	2.03+001	2.07+001	-1.6
6.514	0.191	2.16+001	2.14+001	0.9
6.705	0.190	2.16+001	2.20+001	-1.6

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)			16 DEC 68	540PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
17.565	1.711	5.72+001	5.75+001	-0.6
19.207	1.572	6.23+001	6.27+001	-0.6
20.724	1.462	6.71+001	6.72+001	-0.2
22.142	1.375	7.14+001	7.14+001	0.1
23.477	1.295	7.60+001	7.51+001	1.2
24.743	1.237	7.94+001	7.84+001	1.2
25.961	1.199	8.18+001	8.15+001	0.4

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)			16 DEC 68	600PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
17.580	1.718	5.69+001	5.76+001	-1.1
19.227	1.577	6.21+001	6.27+001	-1.0
20.750	1.468	6.68+001	6.73+001	-0.7
22.177	1.386	7.08+001	7.15+001	-0.9
23.516	1.292	7.61+001	7.52+001	1.2
24.782	1.241	7.92+001	7.85+001	0.8
26.005	1.204	8.15+001	8.16+001	-0.1

Table 17 (Cont.)

				635PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
14.083	1.051	4.59+001	4.63+001	-0.7
15.096	0.980	4.93+001	4.96+001	-0.5
16.051	0.924	5.24+001	5.27+001	-0.5
16.951	0.876	5.53+001	5.56+001	-0.5
17.802	0.827	5.87+001	5.83+001	0.7
18.612	0.791	6.13+001	6.08+001	0.8
19.391	0.767	6.32+001	6.32+001	-0.1

				1140AM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
21.850	0.273	6.95+001	7.05+001	-1.4
22.121	0.270	7.05+001	7.13+001	-1.2
22.389	0.266	7.15+001	7.21+001	-0.8
22.654	0.263	7.23+001	7.28+001	-0.7
22.914	0.258	7.39+001	7.35+001	0.4
23.170	0.253	7.53+001	7.42+001	1.3
23.424	0.254	7.50+001	7.49+001	0.1

				115PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
23.759	0.525	7.48+001	7.58+001	-1.4
24.278	0.513	7.66+001	7.72+001	-0.8
24.787	0.504	7.81+001	7.86+001	-0.6
25.288	0.498	7.91+001	7.98+001	-0.9
25.777	0.480	8.23+001	8.11+001	1.5
26.255	0.477	8.27+001	8.22+001	0.6
26.729	0.470	8.38+001	8.34+001	0.5

Table 17 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)				17DEC68	230PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
28.203	1.423	8.63+001	8.67+001		-0.5
29.605	1.381	8.90+001	8.97+001		-0.7
30.964	1.337	9.22+001	9.23+001		-0.1
32.283	1.302	9.47+001	9.47+001		0.0
33.563	1.258	9.82+001	9.68+001		1.4
34.811	1.239	9.96+001	9.86+001		0.9
36.043	1.224	1.01+002	1.00+002		0.4

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)				17DEC68	455PM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
39.555	3.522	1.04+002	1.04+002		-0.3
43.044	3.456	1.06+002	1.07+002		-0.9
46.460	3.375	1.09+002	1.08+002		0.1
49.824	3.353	1.09+002	1.09+002		0.1
53.154	3.306	1.11+002	1.10+002		1.4
56.473	3.332	1.10+002	1.09+002		0.7
59.823	3.368	1.09+002	1.09+002		0.1

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)				18DEC68	1150AM
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY		PERCENT DEVIATION
60.412	4.981	1.09+002	1.09+002		0.2
65.465	5.124	1.06+002	1.07+002		-1.2
70.621	5.190	1.05+002	1.05+002		-0.6
75.858	5.284	1.03+002	1.03+002		-0.4
81.171	5.343	1.02+002	1.01+002		0.7
86.585	5.484	9.93+001	9.92+001		0.1
92.133	5.612	9.69+001	9.72+001		-0.2

Table 17 (Cont.)

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)		20DEC 68	1025AM	
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
246.036	12.423	7.94+001	7.82+001	1.4
258.676	12.058	7.68+001	7.71+001	-0.4
271.589	12.968	7.63+001	7.60+001	0.4
284.644	13.141	7.53+001	7.49+001	0.6
297.864	13.300	7.45+001	7.39+001	0.9
311.287	13.546	7.31+001	7.31+001	0.1
324.952	13.782	7.18+001	7.25+001	-1.0

THERMAL CONDUCTIVITY DATA FOR ARMCO IRON(4)		20DEC 68	340PM	
MEAN TEMPERATURE	TEMPERATURE DIFFERENCE	OBSERVED THERMAL CONDUCTIVITY	CALCULATED THERMAL CONDUCTIVITY	PERCENT DEVIATION
226.641	7.974	8.09+001	7.98+001	1.3
234.731	8.205	7.87+001	7.92+001	-0.6
242.951	8.236	7.86+001	7.85+001	0.1
251.227	8.316	7.79+001	7.78+001	0.1
259.564	8.357	7.76+001	7.70+001	0.8
267.967	8.449	7.67+001	7.63+001	0.5
276.464	8.545	7.58+001	7.56+001	0.3

Table 18 Electrical resistivity deviations for Armco iron, specimen 4.

MEAN TEMPERATURE	TEMPERATURE RANGE	OBSERVED RESISTANCE	CALCULATED RESISTANCE	PERCENT DEVIATION	INTRINSIC RESISTANCE
6.063	1.452	1.303-004	1.303-004	-0.01	-4.826-008
8.629	3.178	1.304-004	1.304-004	0.05	1.017-007
12.870	5.121	1.307-004	1.308-004	-0.06	3.517-007
6.096	1.470	1.303-004	1.303-004	0.00	-4.826-008
21.974	9.850	1.322-004	1.322-004	0.02	1.852-006
22.005	9.885	1.322-004	1.322-004	0.01	1.852-006
16.855	6.218	1.312-004	1.311-004	0.07	8.517-007
22.646	1.838	1.323-004	1.323-004	-0.01	1.902-006
25.268	3.468	1.330-004	1.331-004	-0.08	2.652-006
32.210	9.164	1.365-004	1.366-004	-0.05	6.152-006
49.762	23.713	1.600-004	1.598-004	0.11	2.965-005
76.035	37.016	2.427-004	2.429-004	-0.12	1.123-004
81.743	6.461	2.636-004	2.639-004	-0.11	1.333-004
96.208	20.877	3.373-004	3.371-004	0.05	2.070-004
129.306	55.696	5.409-004	5.405-004	0.08	4.106-004
208.443	114.282	1.116-003	1.114-003	0.16	9.855-004
259.243	120.367	1.527-003	1.525-003	0.12	1.397-003
221.493	37.178	1.208-003	1.209-003	-0.11	1.078-003
285.007	92.018	1.744-003	1.746-003	-0.09	1.614-003
251.364	58.082	1.452-003	1.451-003	0.04	1.321-003
4.394	0.000	1.303-004	1.303-004	-0.00	-4.826-008
9.696	0.000	1.305-004	1.306-004	-0.06	1.517-007
15.786	0.000	1.310-004	1.309-004	0.04	6.517-007
20.069	0.000	1.317-004	1.316-004	0.03	1.302-006
19.878	0.000	1.316-004	1.316-004	0.02	1.252-006
26.745	0.000	1.336-004	1.336-004	-0.07	3.202-006
35.938	0.000	1.392-004	1.391-004	0.03	8.802-006
55.386	0.000	1.703-004	1.701-004	0.12	3.995-005
77.113	0.000	2.429-004	2.434-004	-0.17	1.126-004
75.738	0.000	2.378-004	2.376-004	0.06	1.074-004
84.360	0.000	2.760-004	2.759-004	0.02	1.457-004
98.003	0.000	3.462-004	3.460-004	0.04	2.158-004
144.158	0.000	6.381-004	6.378-004	0.05	5.078-004
191.793	0.000	9.825-004	9.817-004	0.09	8.522-004
193.141	0.000	9.890-004	9.918-004	-0.28	8.587-004
233.413	0.000	1.303-003	1.303-003	0.02	1.173-003

Table 19 Thermovoltage deviations for Armco iron, specimen 4.

UPPER TEMPERATURE	LOWER TEMPERATURE	OBSERVED THERMOVOLTAGE	CALCULATED THERMOVOLTAGE	DEVIATION
6.766	5.313	-0.03	-0.12	0.09
10.118	6.940	0.06	0.28	-0.22
15.258	10.137	0.31	0.24	0.07
6.800	5.330	-0.02	-0.12	0.10
26.560	16.710	2.68	2.71	-0.03
26.606	16.721	2.72	2.73	-0.01
19.775	13.557	0.73	0.58	0.15
23.551	21.713	0.49	0.57	-0.08
26.964	23.496	1.41	1.54	-0.13
36.655	27.491	8.60	8.72	-0.12
61.507	37.794	77.53	77.36	0.17
94.938	57.922	282.46	282.65	-0.19
84.986	78.525	55.32	55.19	0.13
106.759	85.882	218.50	218.42	0.08
157.630	101.934	734.22	734.13	0.09
266.661	152.379	1636.76	1636.91	-0.15
320.650	200.283	1597.60	1597.72	-0.12
240.238	203.059	534.88	534.46	0.42
331.843	239.825	1149.44	1149.36	0.08
280.736	222.654	794.32	794.22	0.10

Table 20 Transport properties of Armco iron, specimen 2.

Temp (K)	Thermal Conductivity (Wm ⁻¹ K ⁻¹)	Electrical Resistivity (μ ohm m)	Lorenz ratio x 10 ⁸ (V ² /K ²)	Thermo- power (μ V/K)
6	21.7	0.006905	2.49	0.02
7	25.6	0.006903	2.52	0.06
8	29.2	0.006911	2.53	0.07
9	32.8	0.006920	2.53	0.06
10	36.4	0.006926	2.52	0.07
12	43.5	0.006929	2.51	0.13
14	50.7	0.006932	2.51	0.22
16	57.9	0.006941	2.51	0.32
18	65.0	0.006957	2.51	0.43
20	71.8	0.006981	2.50	0.54
25	87.0	0.007067	2.46	0.82
30	98.9	0.007196	2.37	1.18
35	107	0.007386	2.26	1.67
40	113	0.007664	2.16	2.28
45	115	0.008051	2.06	3.00
50	116	0.008562	1.99	3.79
55	115	0.009202	1.93	4.63
60	114	0.009976	1.89	5.51
65	112	0.01088	1.87	6.38
70	110	0.01191	1.87	7.24
75	107	0.01306	1.87	8.07
80	105	0.01432	1.88	8.86
85	103	0.01568	1.89	9.60
90	100	0.01713	1.91	10.30
95	98.4	0.01867	1.93	10.95
100	96.6	0.02028	1.96	11.54
110	93.4	0.02371	2.01	12.58
120	90.8	0.02736	2.07	13.44
130	88.7	0.03119	2.13	14.13
140	87.1	0.03516	2.19	14.67
150	85.8	0.03923	2.24	15.07
160	84.7	0.04340	2.30	15.37
170	83.9	0.04765	2.35	15.57
180	83.1	0.05196	2.40	15.69
190	82.4	0.05633	2.44	15.74
200	81.8	0.06077	2.48	15.73
220	80.5	0.06983	2.55	15.56
240	79.1	0.07918	2.61	15.23
260	77.5	0.08888	2.65	14.77
280	75.9	0.09903	2.68	14.19
300	74.3	0.10970	2.72	13.51

Table 21 Transport properties of Armco iron, specimen 2a.

Temp (K)	Thermal Conductivity (Wm ⁻¹ K ⁻¹)	Electrical Resistivity (μ ohm m)	Lorenz ratio x 10 ⁸ (V ² /K ²)	Thermo- power (μ V/K)
6	19.7	0.007645	2.52	-0.02
7	23.2	0.007645	2.53	0.08
8	26.6	0.007658	2.54	0.11
9	29.9	0.007669	2.55	0.11
10	33.2	0.007674	2.55	0.11
12	39.8	0.007676	2.54	0.15
14	46.4	0.007676	2.54	0.23
16	52.9	0.007685	2.54	0.33
18	59.4	0.007702	2.54	0.44
20	65.6	0.007726	2.53	0.56
25	79.8	0.007812	2.49	0.87
30	91.2	0.007936	2.41	1.25
35	99.6	0.008119	2.31	1.75
40	105	0.008388	2.21	2.37
45	108	0.008766	2.11	3.09
50	110	0.009268	2.04	3.87
55	110	0.009902	1.98	4.72
60	109	0.01067	1.94	5.58
65	108	0.01157	1.92	6.45
70	106	0.01259	1.91	7.30
75	104	0.01374	1.91	8.12
80	102	0.01500	1.91	8.91
85	100	0.01635	1.93	9.65
90	98.4	0.01781	1.95	10.34
95	96.7	0.01934	1.97	10.97
100	95.1	0.02096	1.99	11.56
110	92.3	0.02438	2.05	12.59
120	90.1	0.02803	2.10	13.43
130	88.3	0.03185	2.16	14.10
140	86.9	0.03581	2.22	14.63
150	85.7	0.03988	2.28	15.02
160	84.7	0.04404	2.35	15.31
170	83.8	0.04827	2.38	15.50
180	83.0	0.05258	2.42	15.62
190	82.2	0.05694	2.46	15.67
200	81.4	0.06137	2.50	15.66
220	79.8	0.07042	2.56	15.50
240	78.2	0.07978	2.60	15.18
260	76.6	0.08952	2.64	14.72
280	75.3	0.09971	2.68	14.14

Table 22 Transport properties of Armco iron, specimen 4.

Temp (K)	Thermal Conductivity (Wm ⁻¹ K ⁻¹)	Electrical Resistivity (μohm m)	Lorenz ratio x 10 ⁸ (V ² /K ²)	Thermo- power (μV/K)
6	19.6	0.007675	2.51	-0.07
7	23.0	0.007664	2.52	0.07
8	26.3	0.007673	2.52	0.11
9	29.6	0.007685	2.53	0.11
10	32.9	0.007694	2.53	0.11
12	39.4	0.007702	2.53	0.13
14	46.0	0.007706	2.53	0.19
16	52.5	0.007715	2.53	0.28
18	58.9	0.007730	2.53	0.39
20	65.1	0.007752	2.52	0.50
25	79.1	0.007834	2.48	0.80
50	90.5	0.007960	2.40	1.18
35	98.9	0.008149	2.30	1.66
40	105	0.008427	2.20	2.27
45	108	0.008814	2.11	2.97
50	109	0.009324	2.04	3.74
55	110	0.009965	1.98	4.58
60	109	0.01074	1.95	5.44
65	107	0.01164	1.92	6.30
70	106	0.01267	1.91	7.15
75	104	0.01382	1.91	7.98
80	102	0.01507	1.92	8.77
85	99.8	0.01643	1.93	9.51
90	97.9	0.01789	1.95	10.20
95	96.2	0.01942	1.97	10.85
100	94.6	0.02104	1.99	11.44
110	91.8	0.02446	2.04	12.47
120	89.6	0.02811	2.10	13.31
130	87.9	0.03193	2.16	13.99
140	86.5	0.03589	2.22	14.51
150	85.4	0.03996	2.28	14.91
160	84.5	0.04412	2.33	15.20
170	83.8	0.04836	2.38	15.39
180	83.1	0.05267	2.43	15.51
190	82.4	0.05704	2.47	15.56
200	81.8	0.06146	2.51	15.55
220	80.4	0.07052	2.58	15.39
240	78.8	0.07986	2.62	15.07
260	77.0	0.08957	2.65	14.62
280	75.3	0.09973	2.68	14.05
300	73.8	0.11040	2.71	13.36

Table 23 The Lorenz ratio and intrinsic electrical resistivity of Armco iron
 (average of the results from specimens 2, 2a, and 4.)

Temp (K)	Lorenz ratio $\times 10^8$ (V 2 /K 2)	Intrinsic Electrical Resistivity (μ ohm m)
4	2.263	0.0000
5	2.455	0.0000
6	2.505	0.0000
7	2.523	0.0000
8	2.531	0.0000
9	2.533	0.0000
10	2.532	0.0000
12	2.529	0.0000
14	2.528	0.0000
16	2.528	0.0000
18	2.527	0.0001
20	2.521	0.0001
25	2.477	0.0002
30	2.395	0.0003
35	2.292	0.0005
40	2.188	0.0008
45	2.096	0.0011
50	2.021	0.0016
55	1.965	0.0023
60	1.927	0.0030
65	1.905	0.0040
70	1.895	0.0050
75	1.895	0.0061
80	1.903	0.0074
85	1.917	0.0087
90	1.935	0.0102
95	1.956	0.0117
100	1.980	0.0134
110	2.034	0.0168
120	2.091	0.0204
130	2.150	0.0242
140	2.209	0.0282
150	2.266	0.0323
160	2.320	0.0364
170	2.371	0.0407
180	2.418	0.0450
190	2.461	0.0494
200	2.499	0.0538
220	2.562	0.0628
240	2.610	0.0722
260	2.647	0.0819
280	2.682	0.0921
300	2.724	0.1028

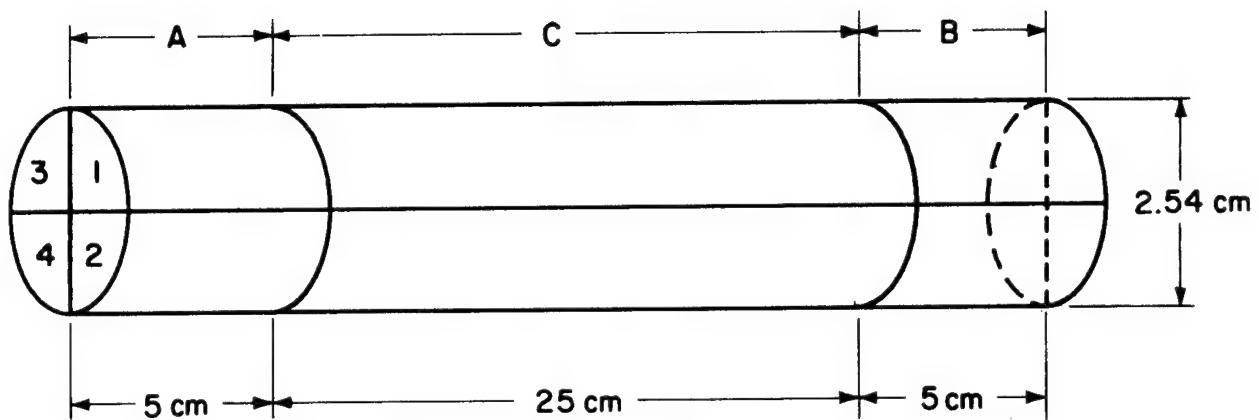


Figure 1. Division of Armco iron rod. Each of the 12 pieces shown was machined into a circular cylinder for measurement.

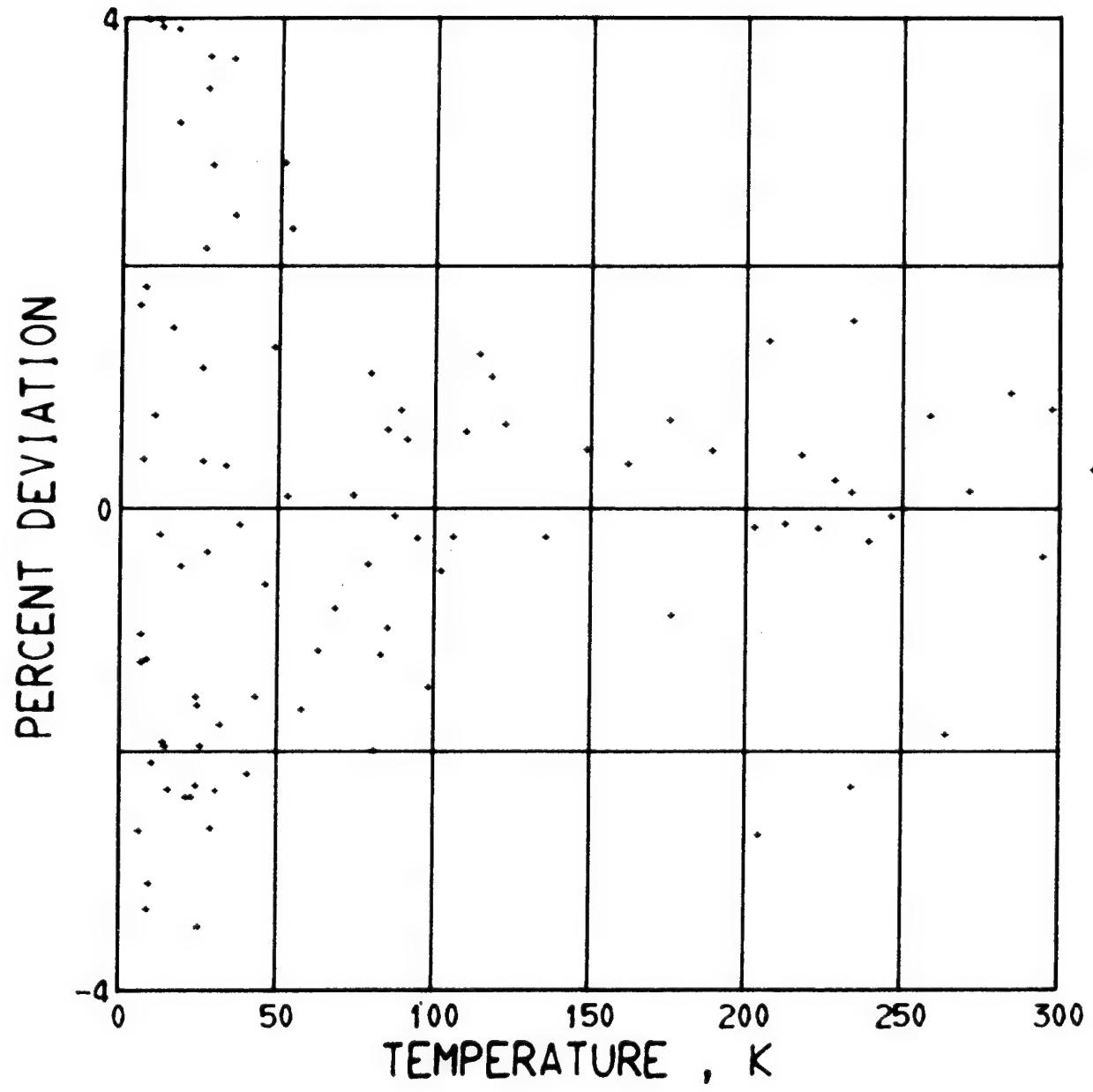


Figure 2. Thermal conductivity deviations for Armco iron, specimen 2.

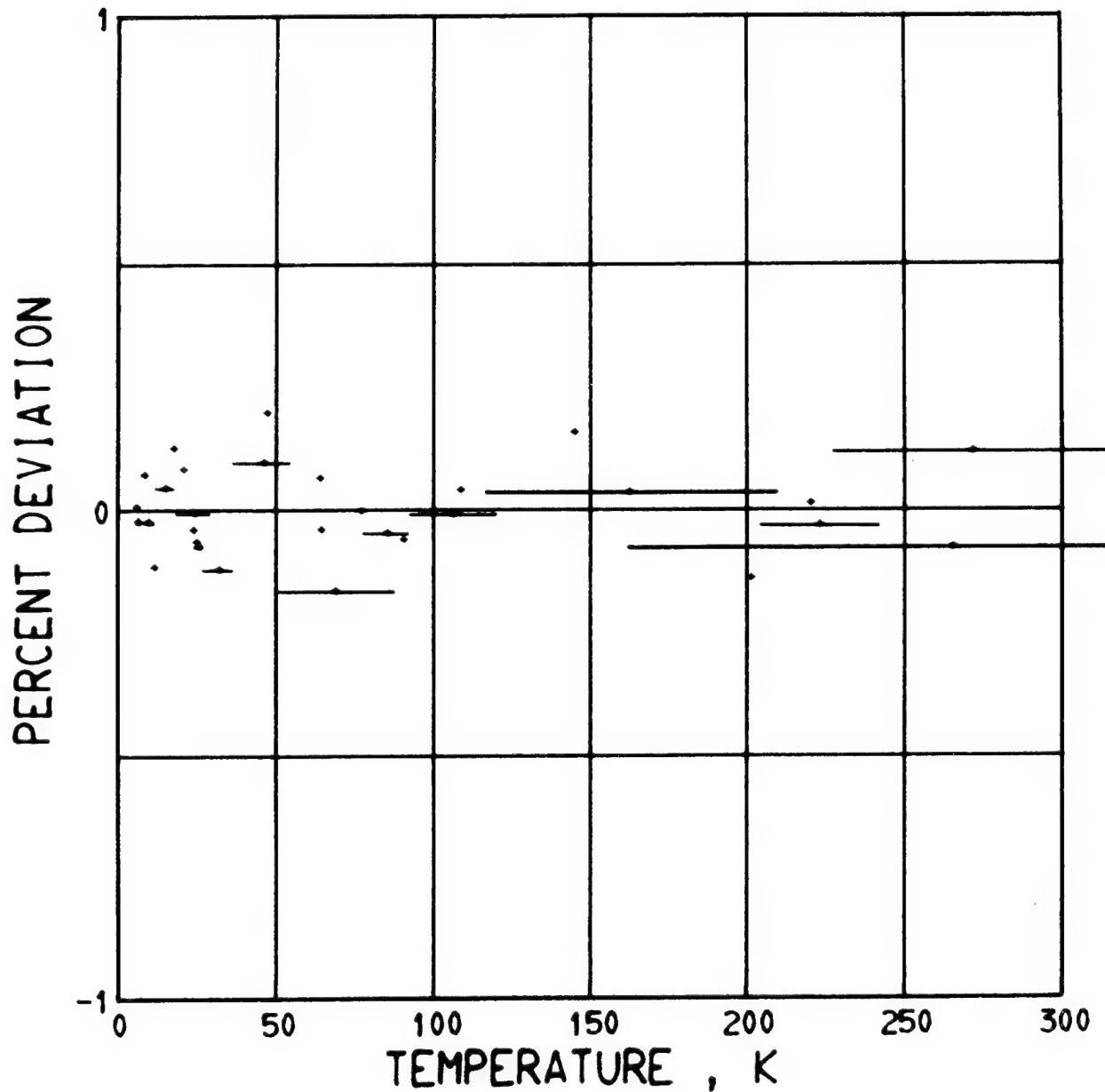


Figure 3. Electrical resistivity deviations for Armco iron, specimen 2.

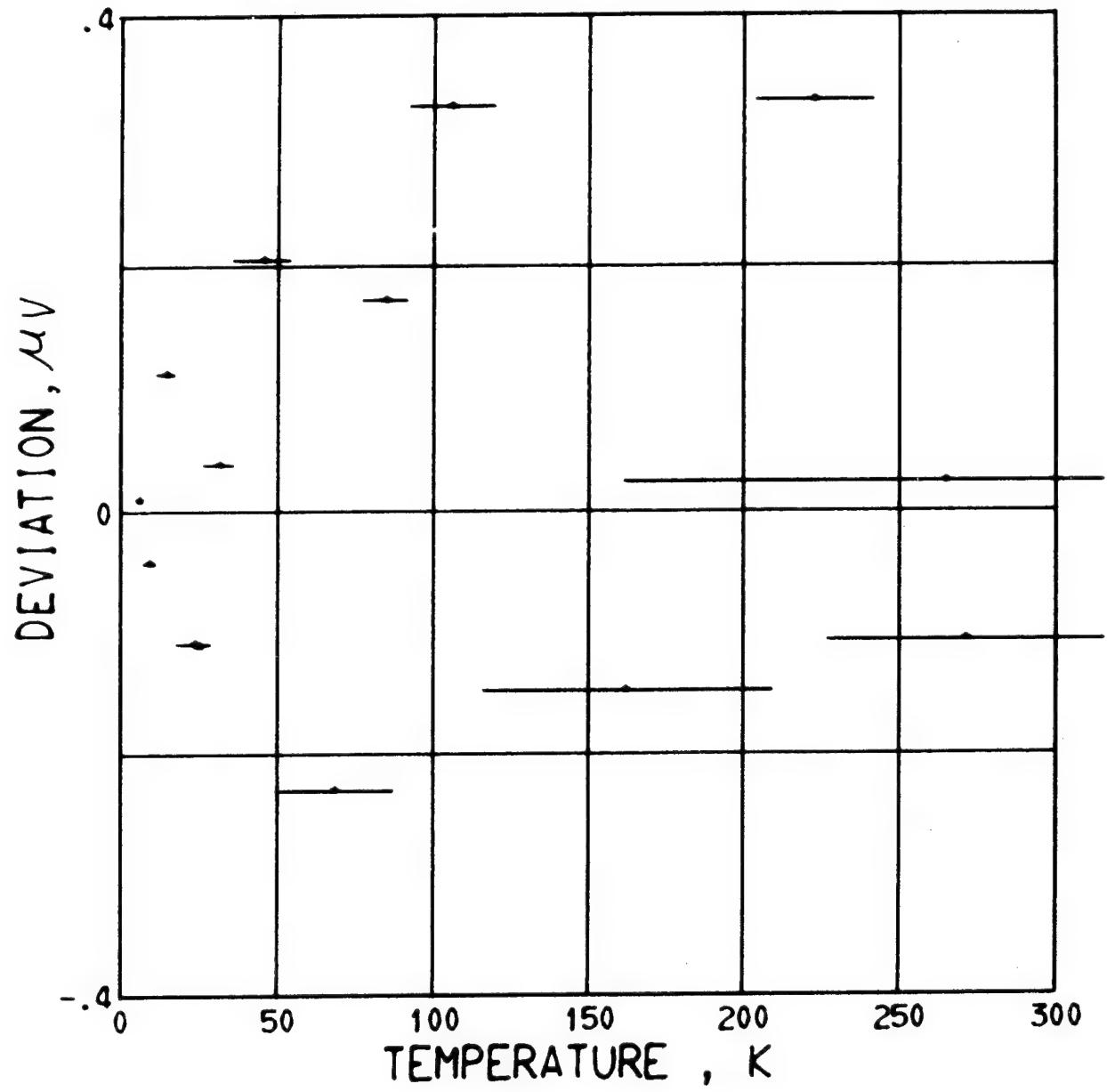


Figure 4. Thermovoltage deviations for Armco iron, specimen 2.

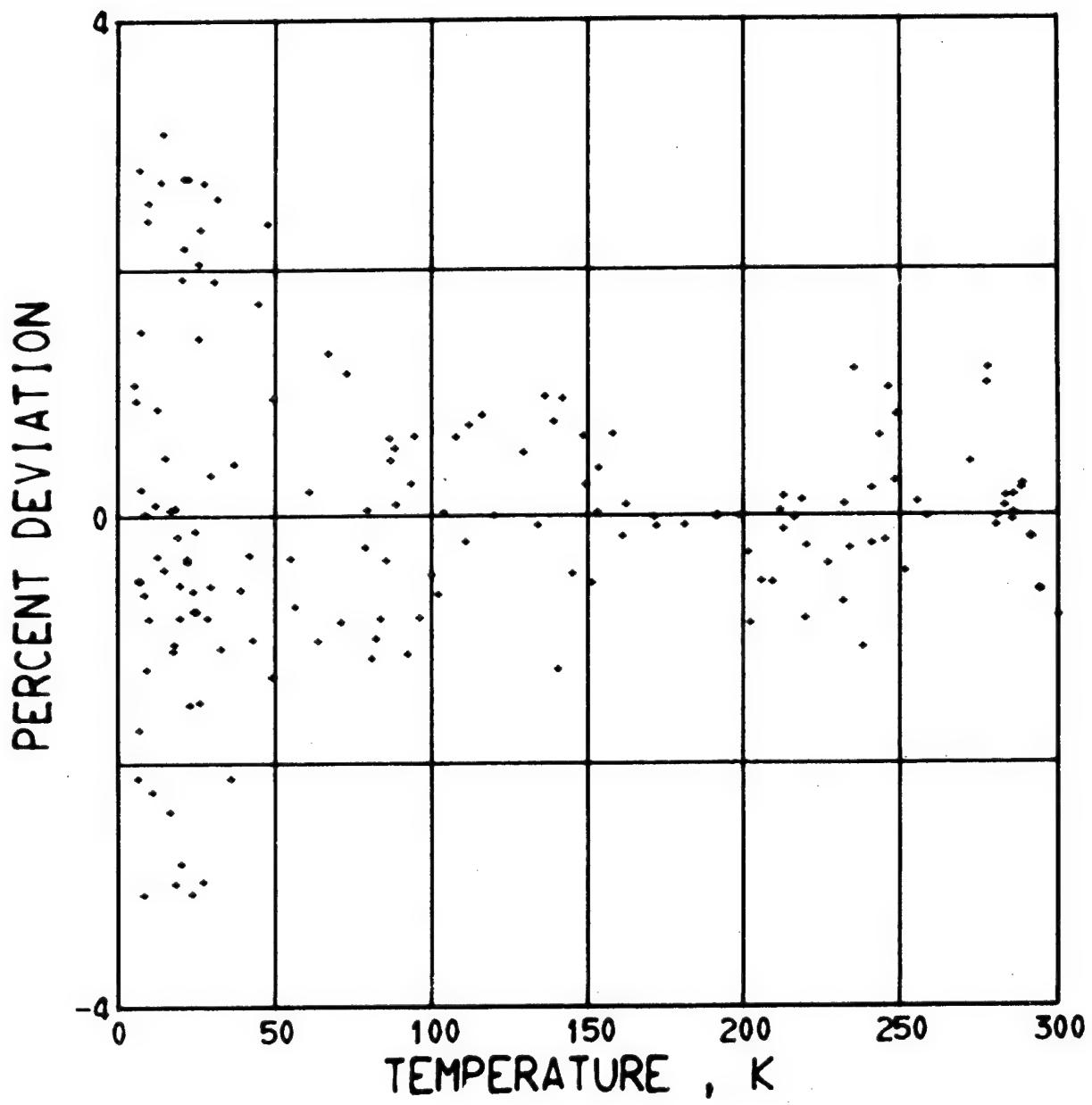


Figure 5. Thermal conductivity deviations for Armco iron, specimen 2a.

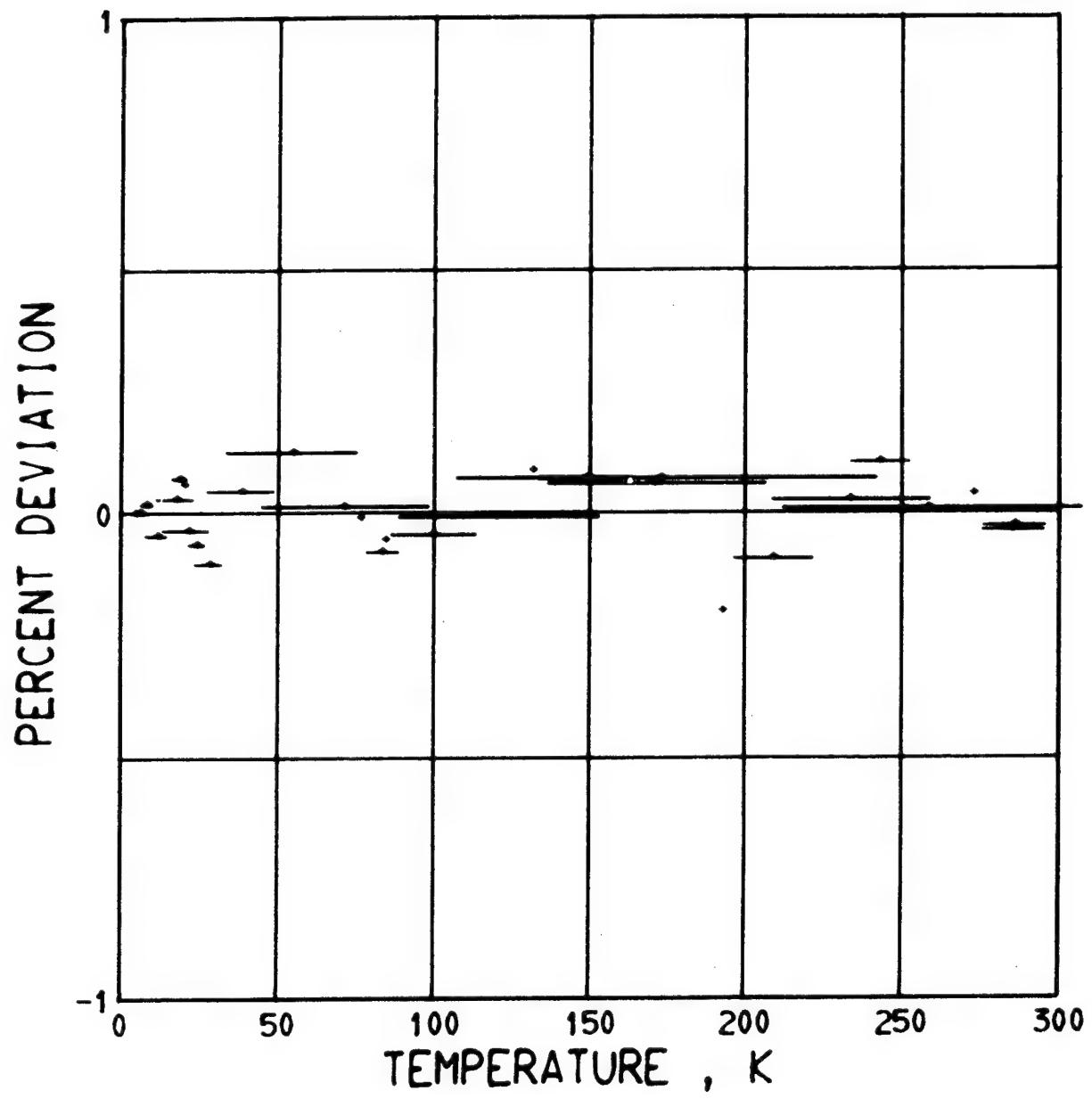


Figure 6. Electrical resistivity deviations for Armco iron, specimen 2a.

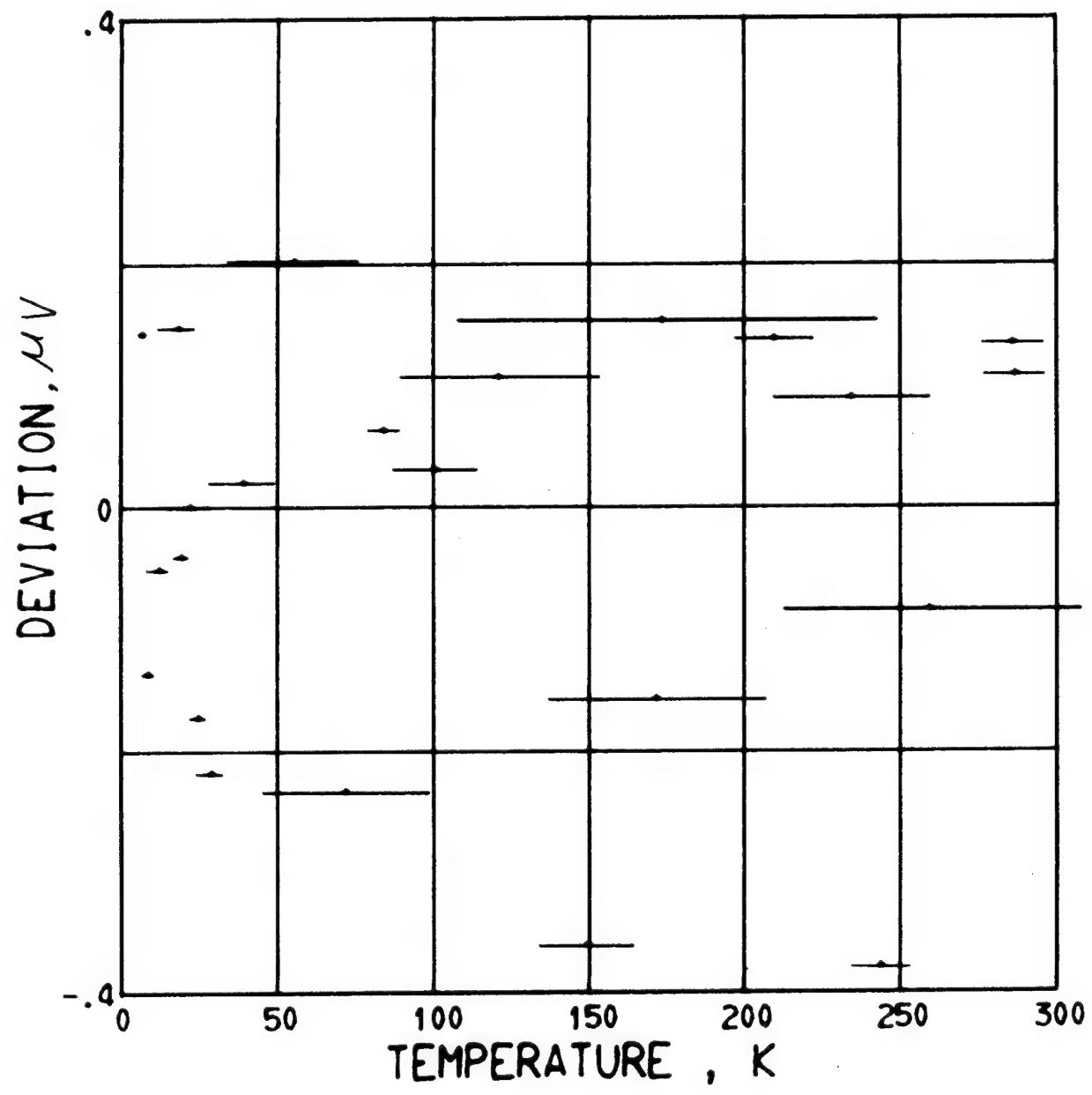


Figure 7. Thermovoltage deviations for Armco iron, specimen 2a.

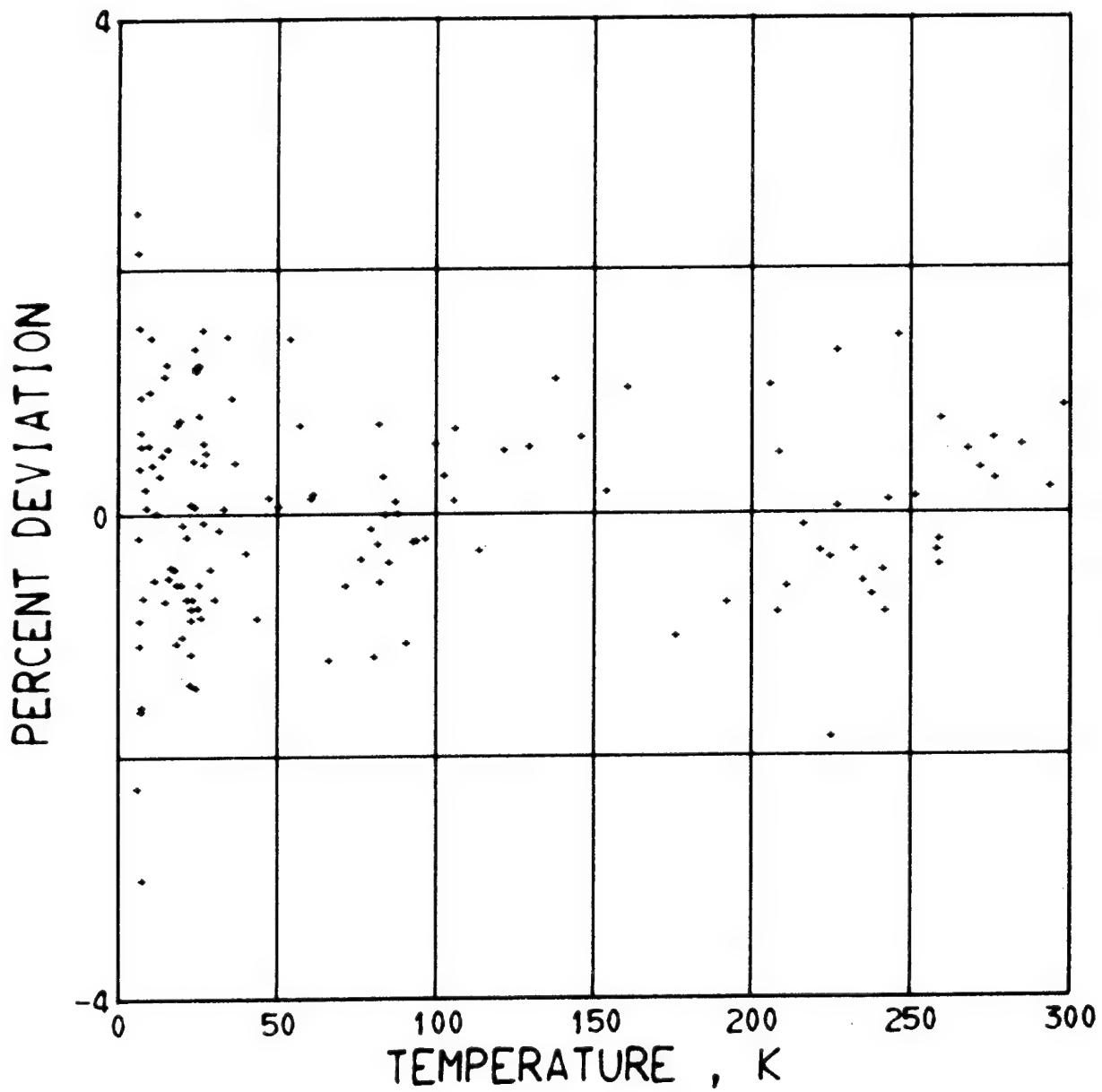


Figure 8. Thermal conductivity deviations for Armco iron, specimen 4.

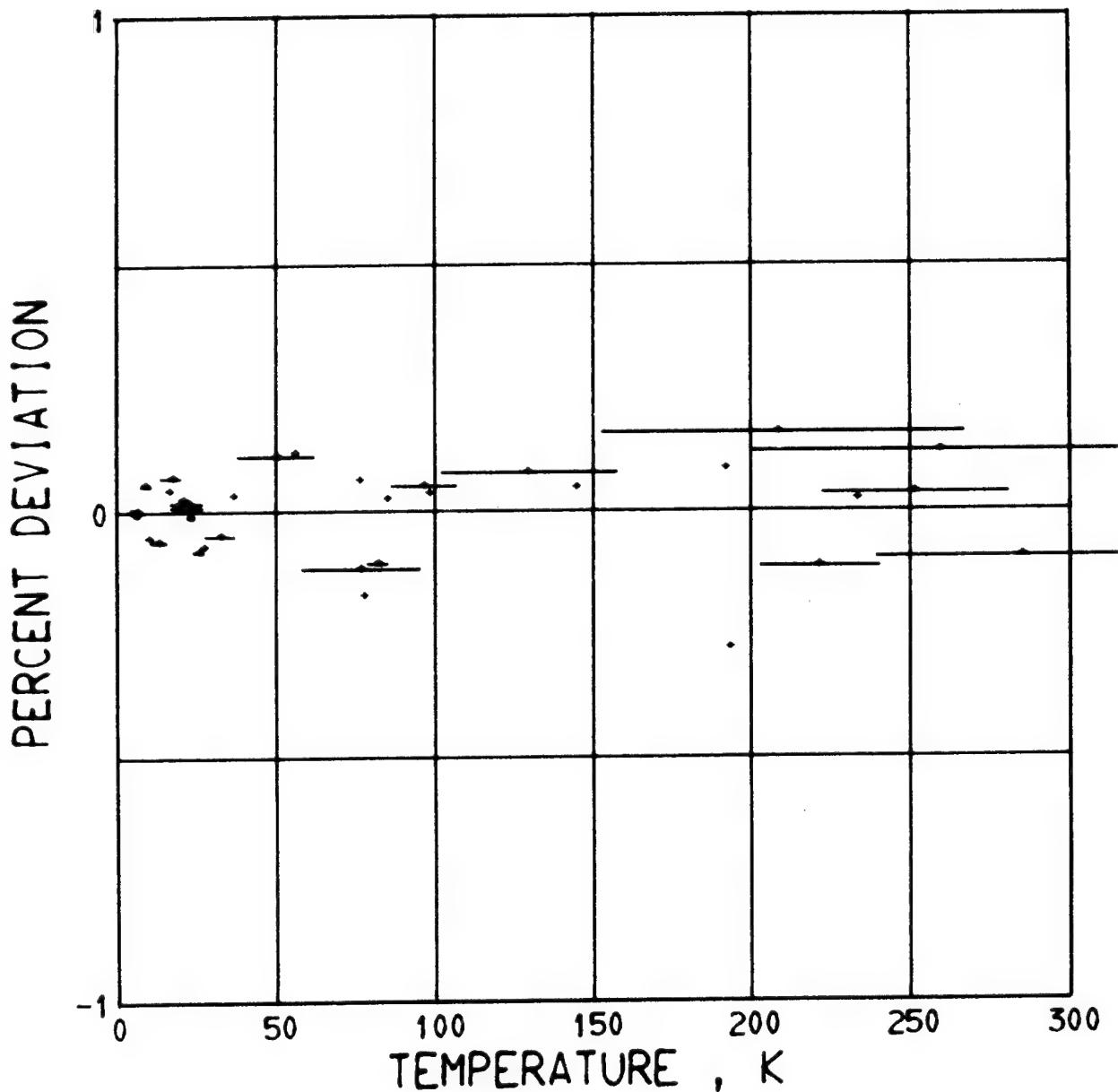


Figure 9. Electrical resistivity deviations for Armco iron, specimen 4.

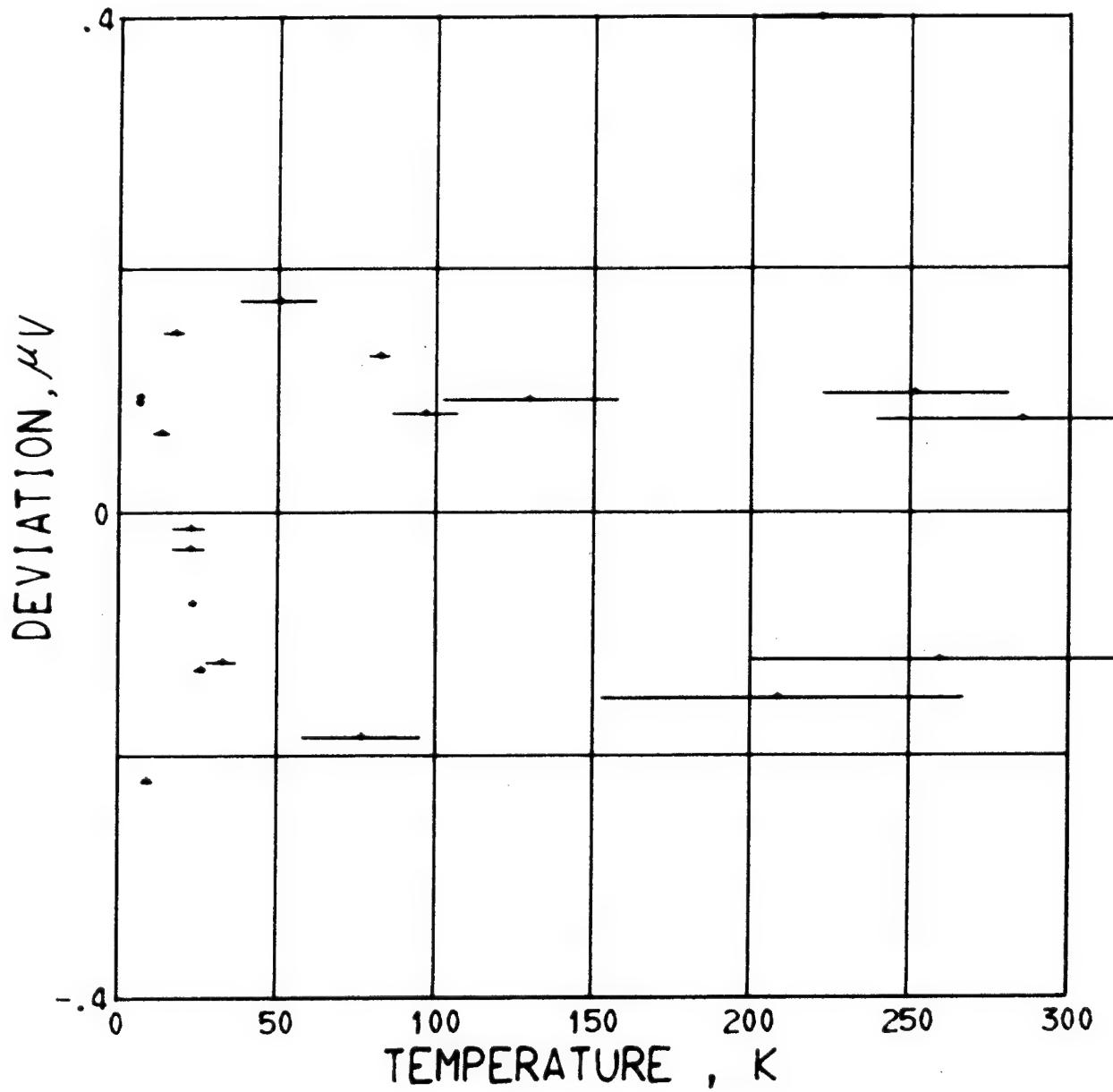


Figure 10. Thermovoltage deviations for Armco iron, specimen 4.

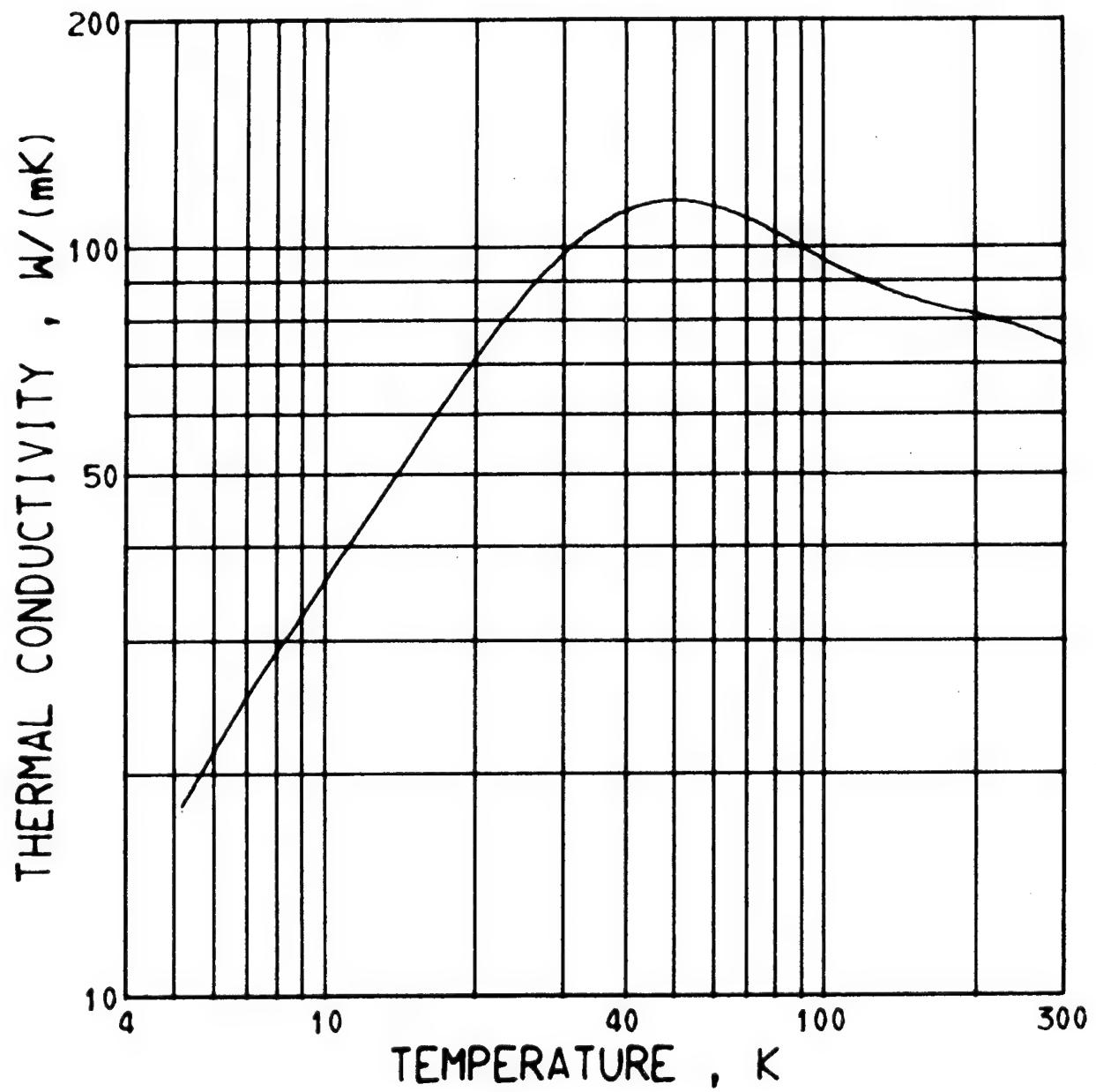


Figure 11a. Thermal conductivity of Armco iron, specimen 2.

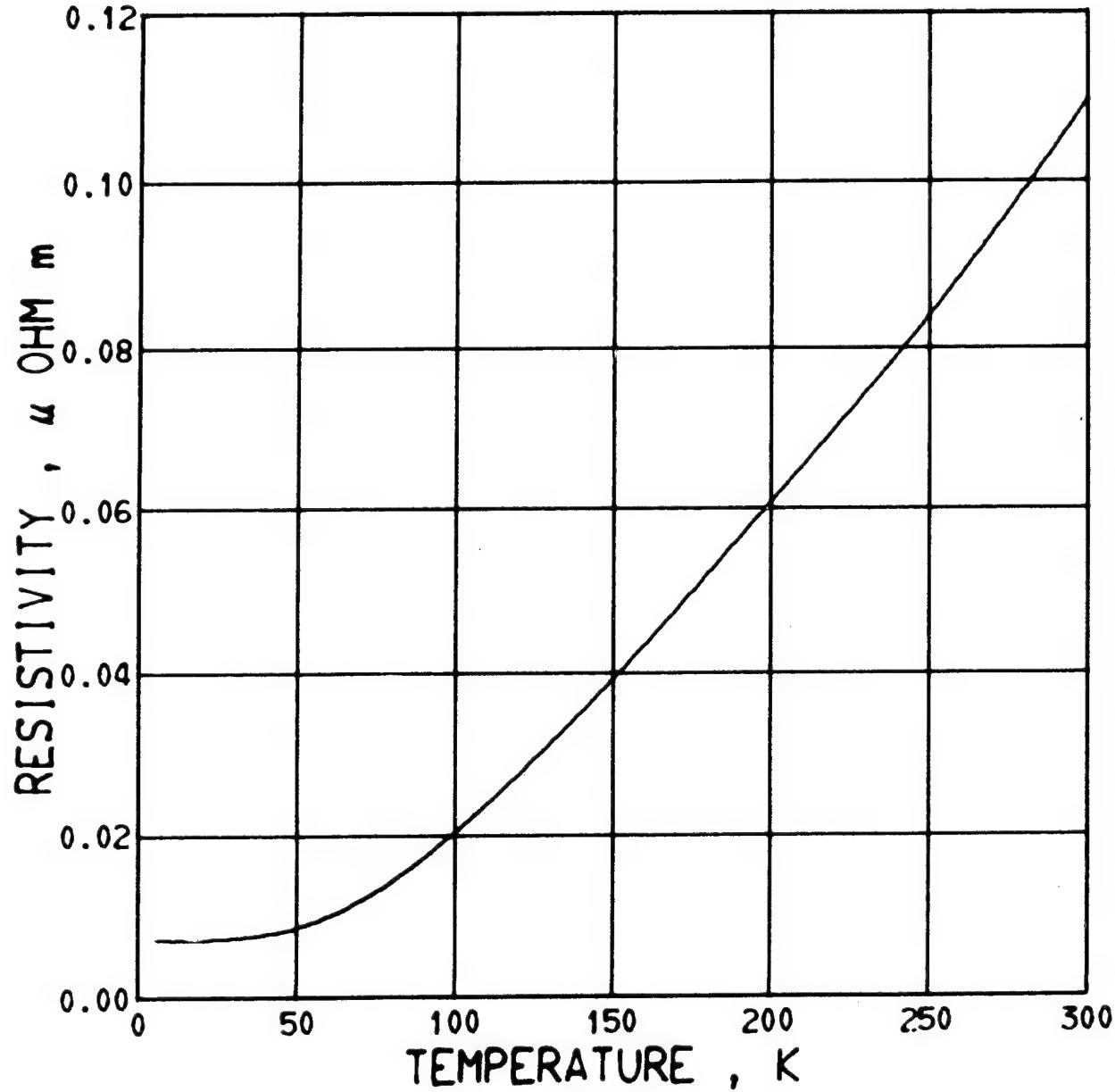


Figure 11b. Electrical resistivity of Armco iron, specimen 2.

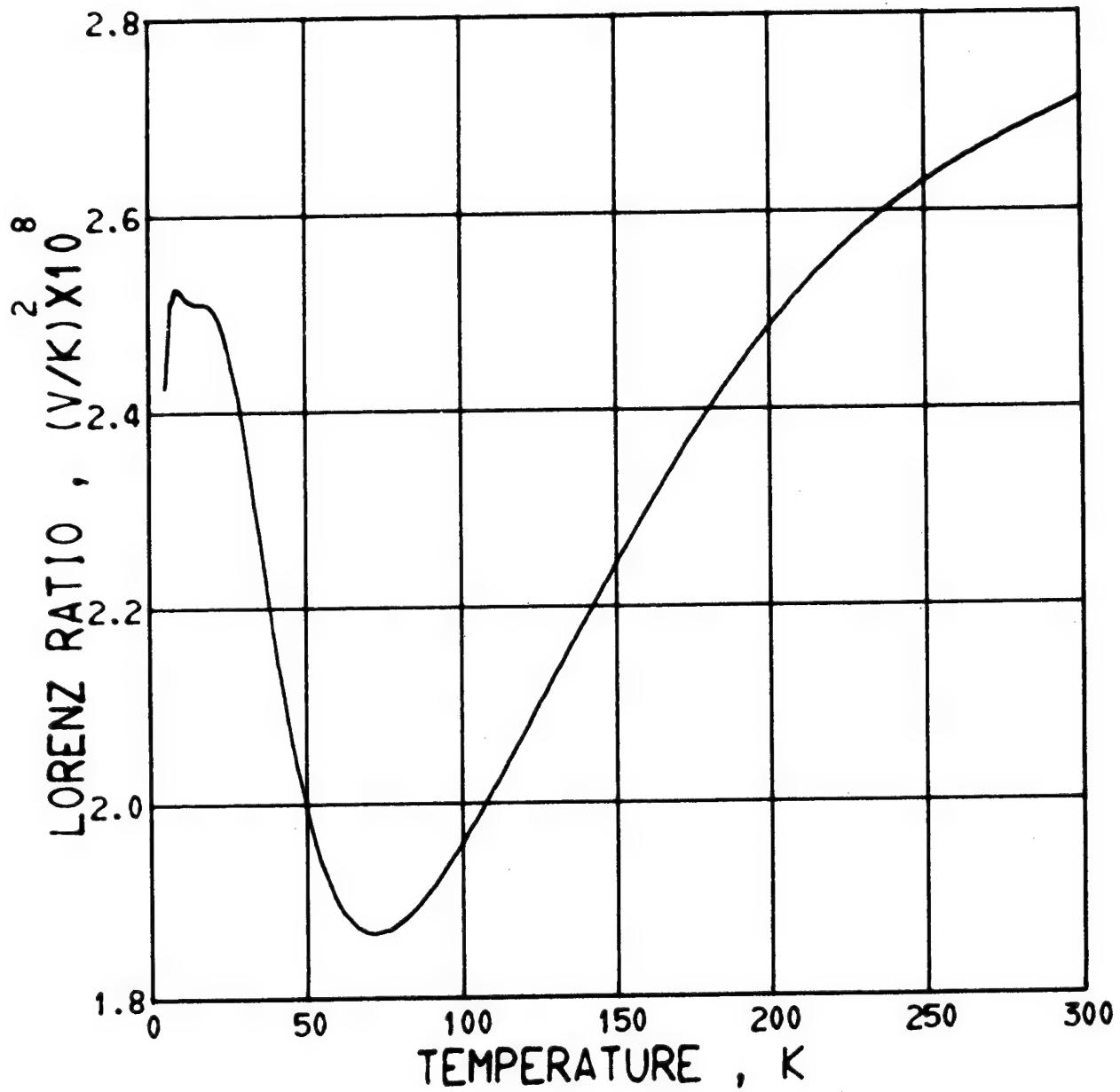


Figure 11c. Lorenz ratio of Armco iron, specimen 2.

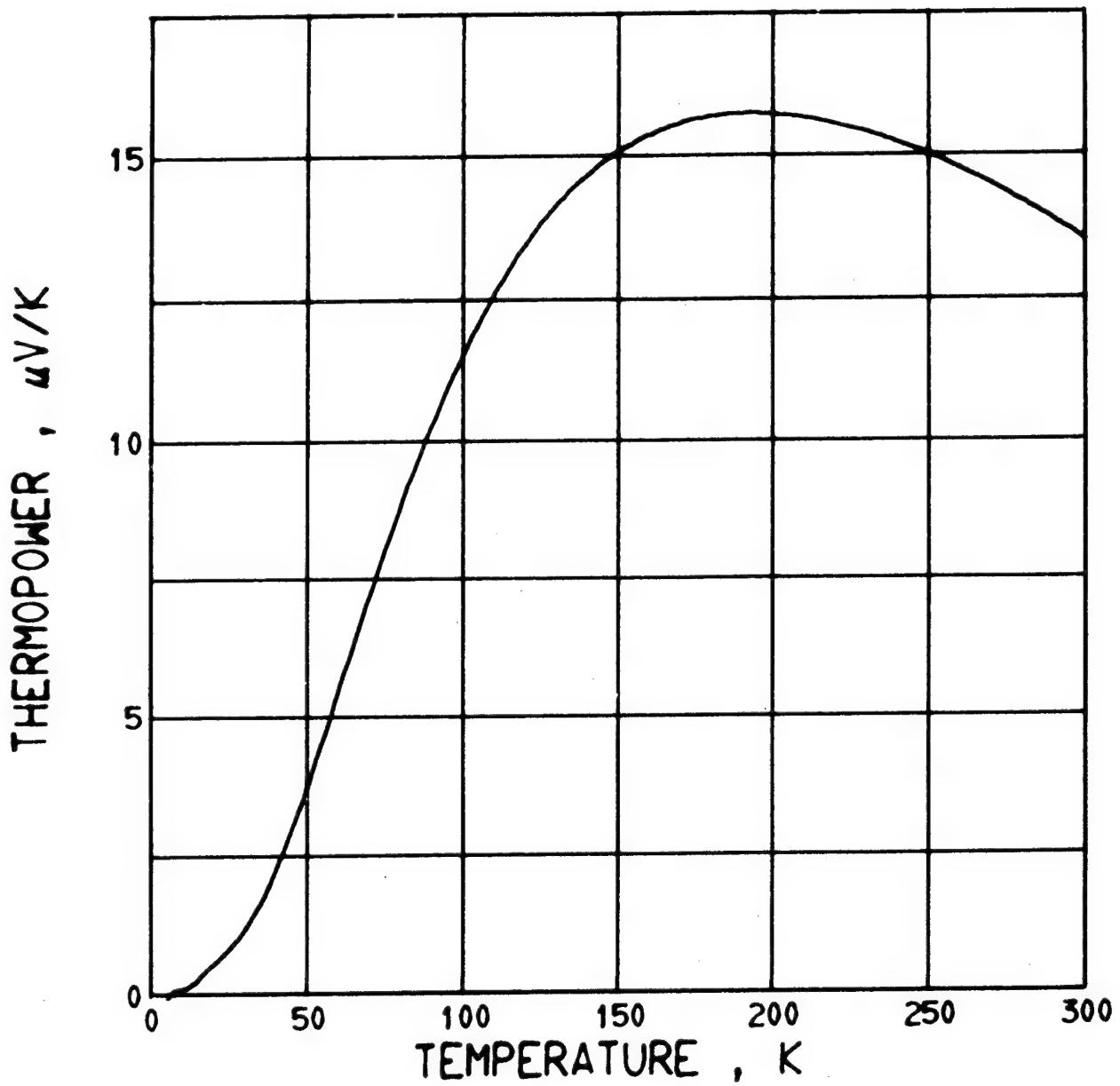


Figure 11d. Thermopower of Armco iron, specimen 2.

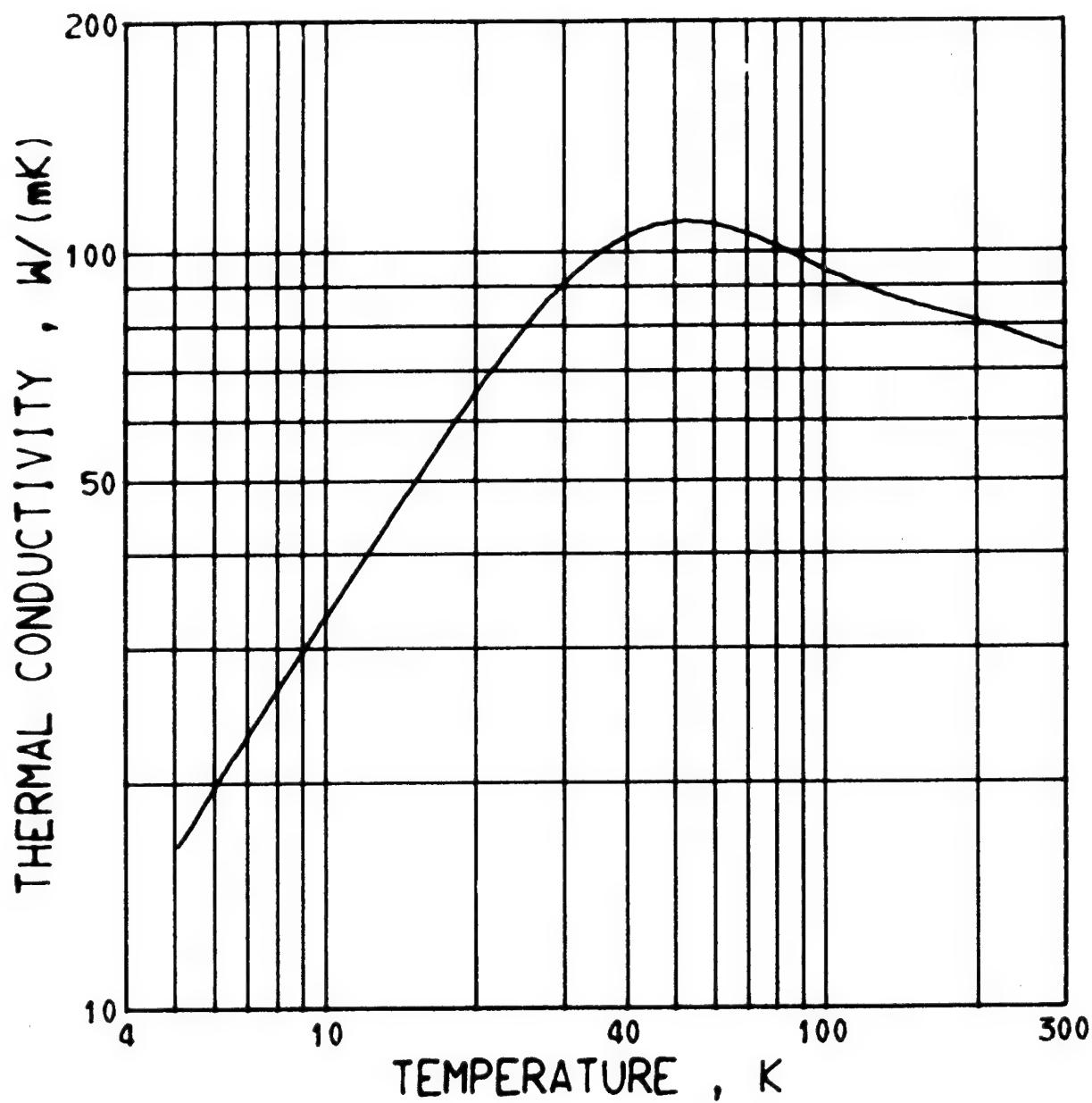


Figure 12a. Thermal conductivity of Armco iron, specimen 2a.

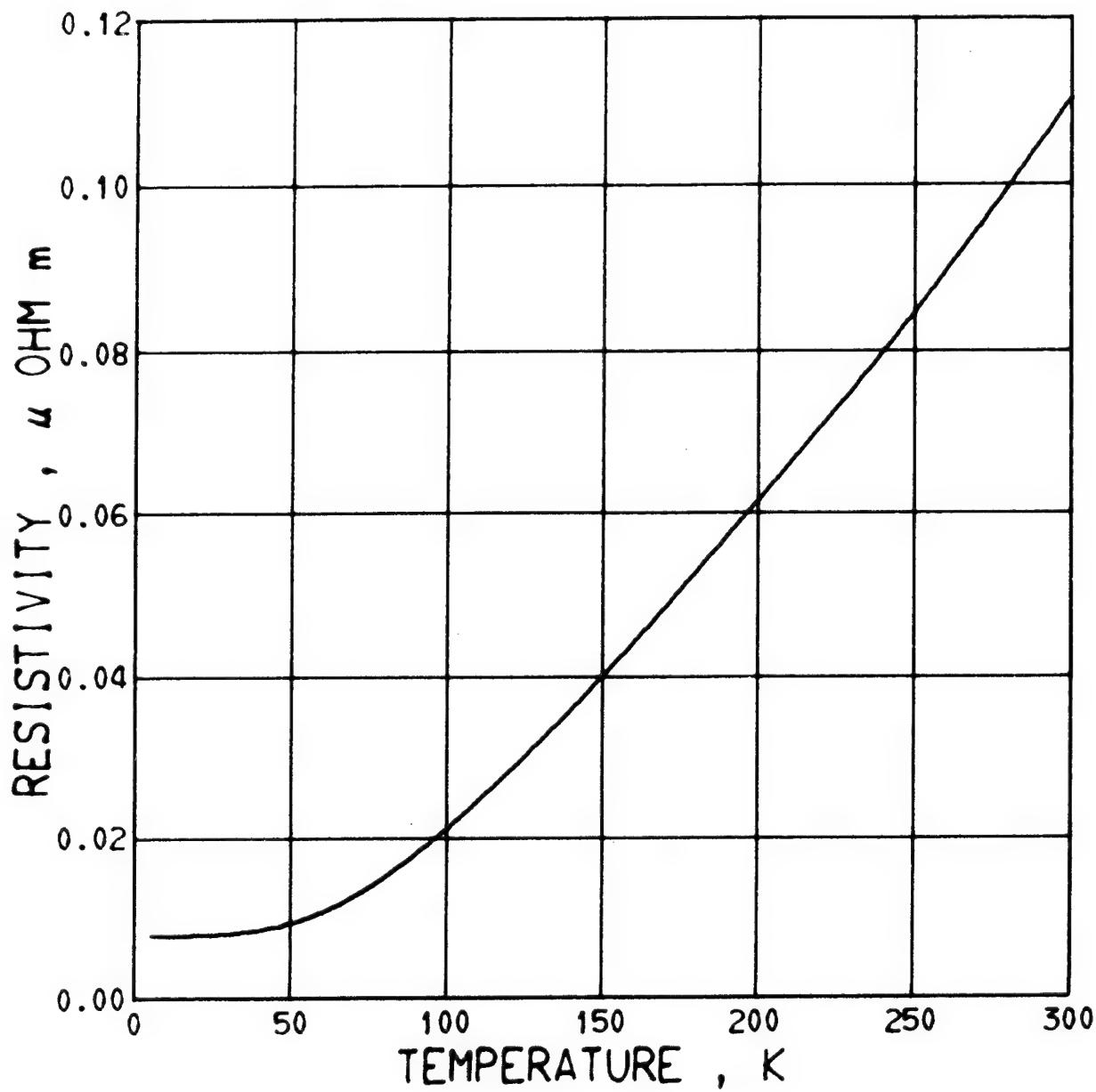


Figure 12b. Electrical resistivity of Armco iron, specimen 2a.

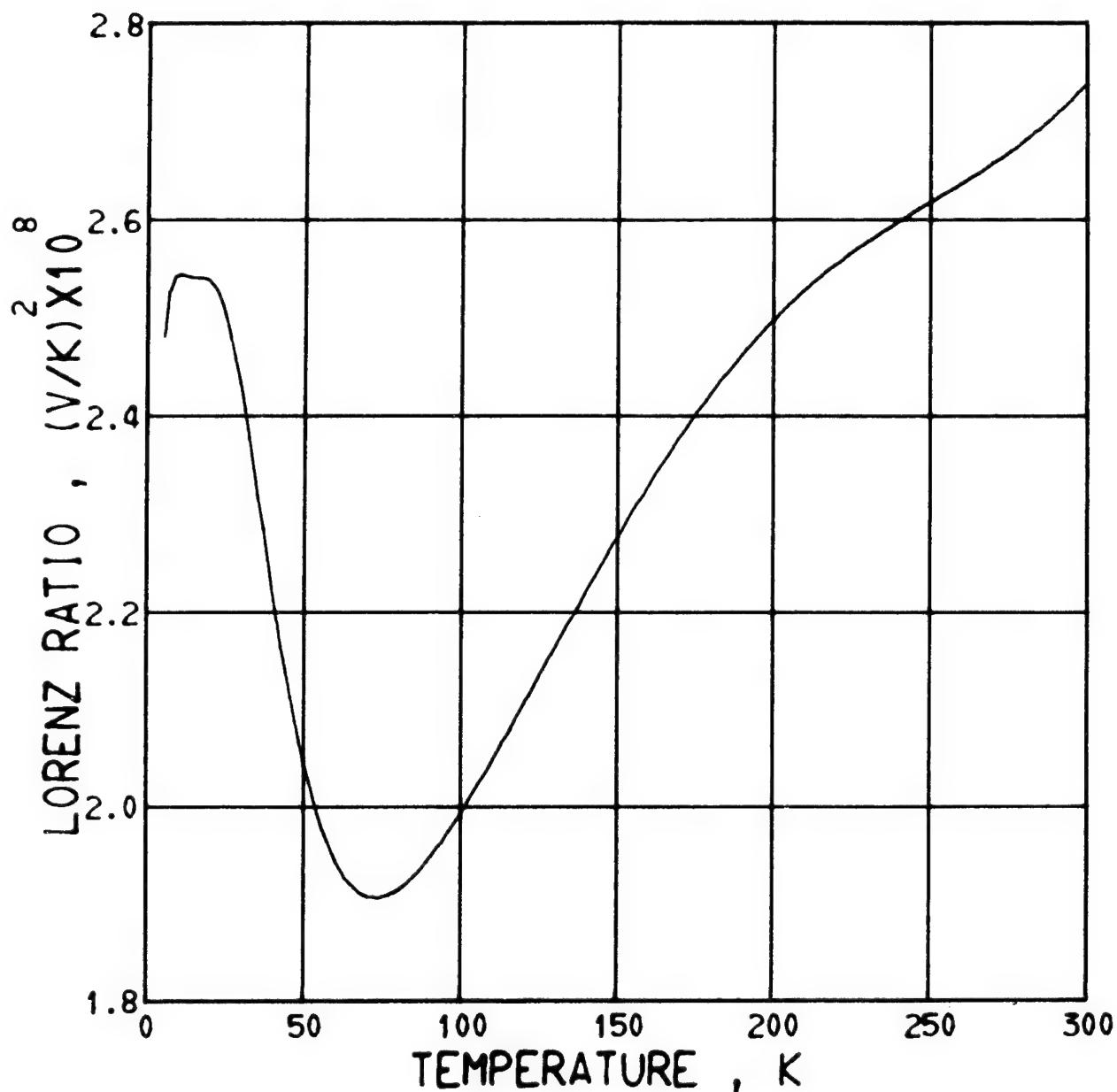


Figure 12c. Lorenz ratio of Armco iron, specimen 2a.

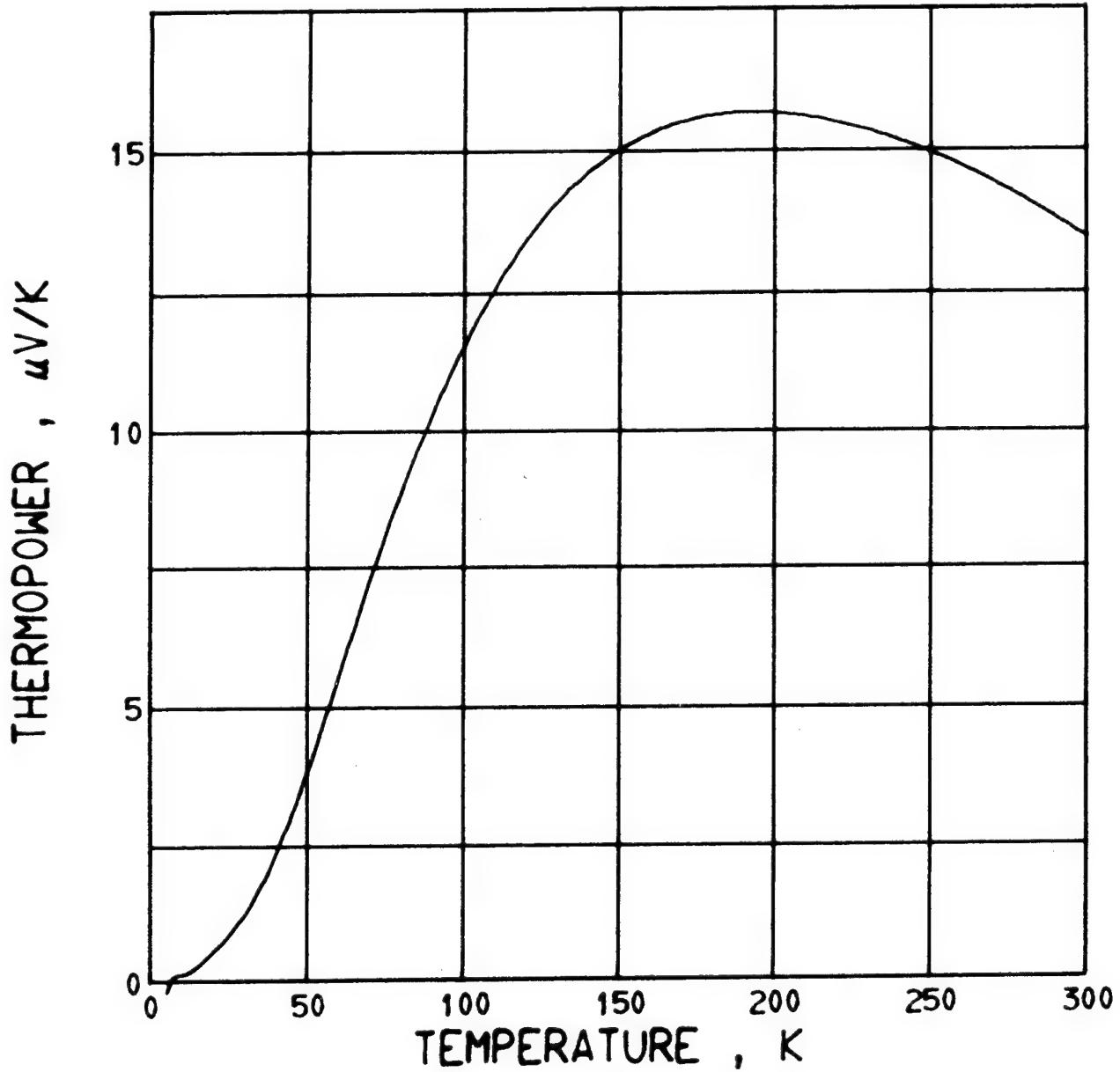


Figure 12d. Thermopower of Armco iron, specimen 2a.

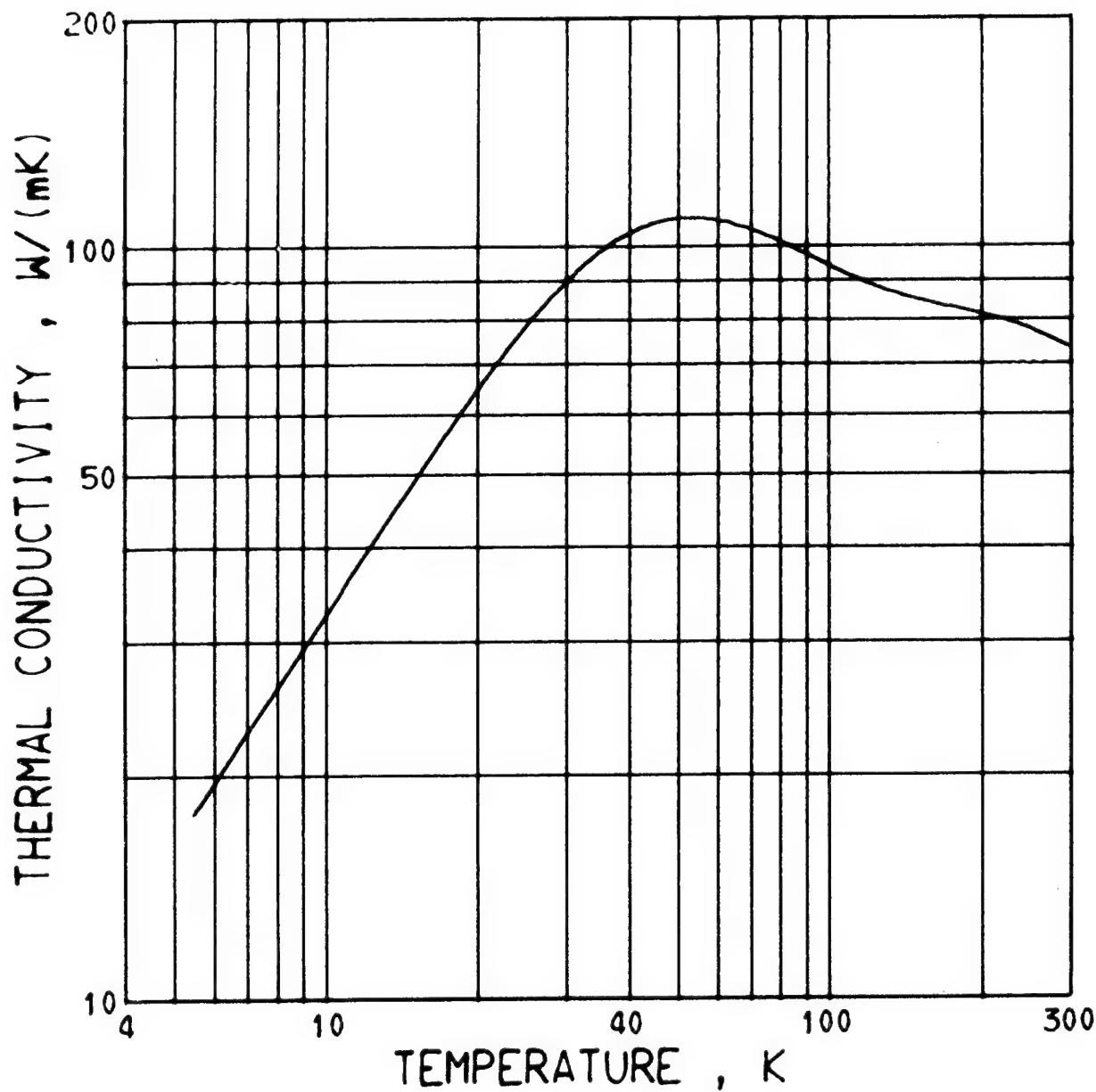


Figure 13a. Thermal conductivity of Armco iron, specimen 4.

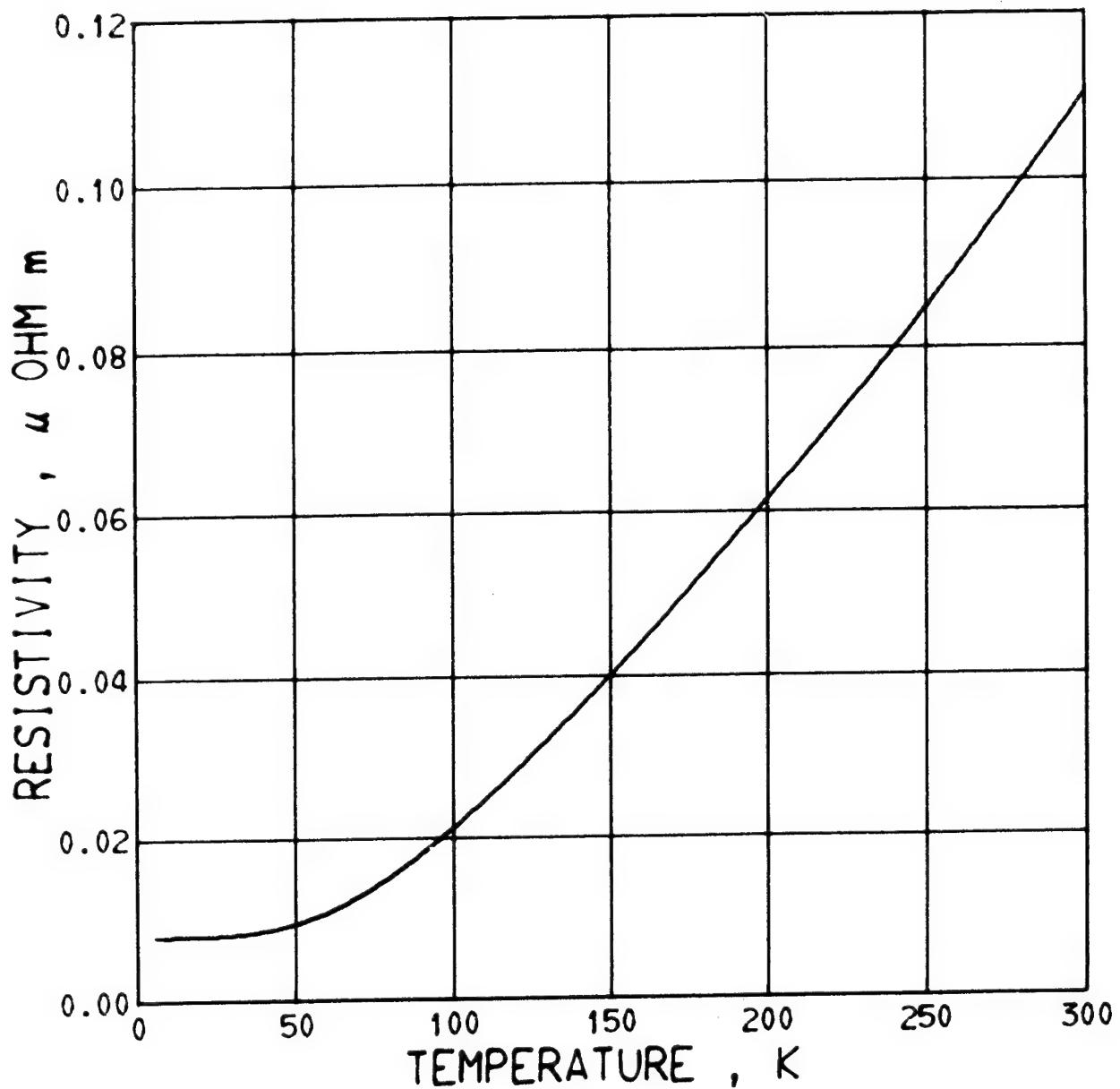


Figure 13b. Electrical resistivity of Armco iron, specimen 4.

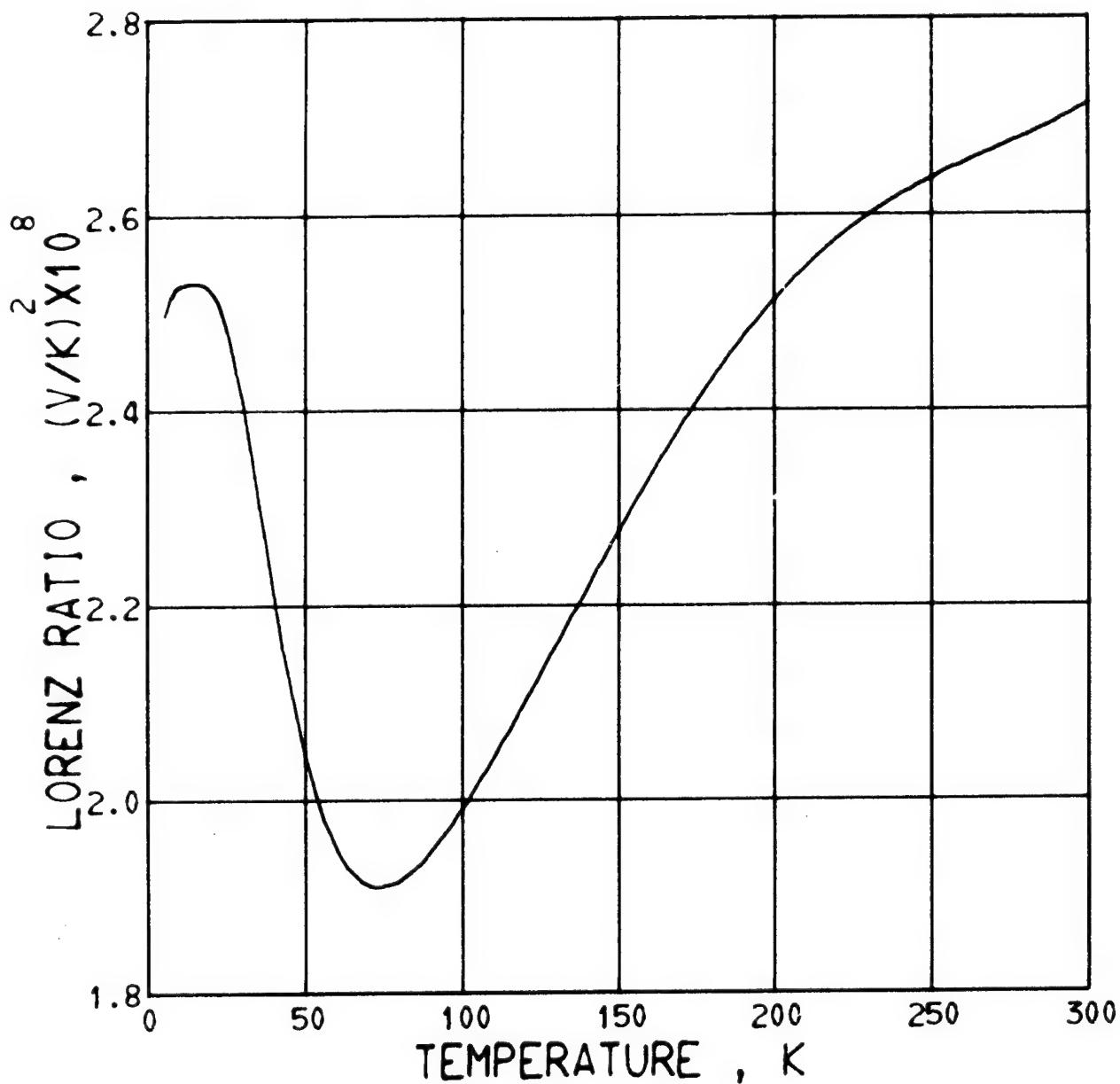


Figure 13c. Lorenz ratio of Armco iron, specimen 4.

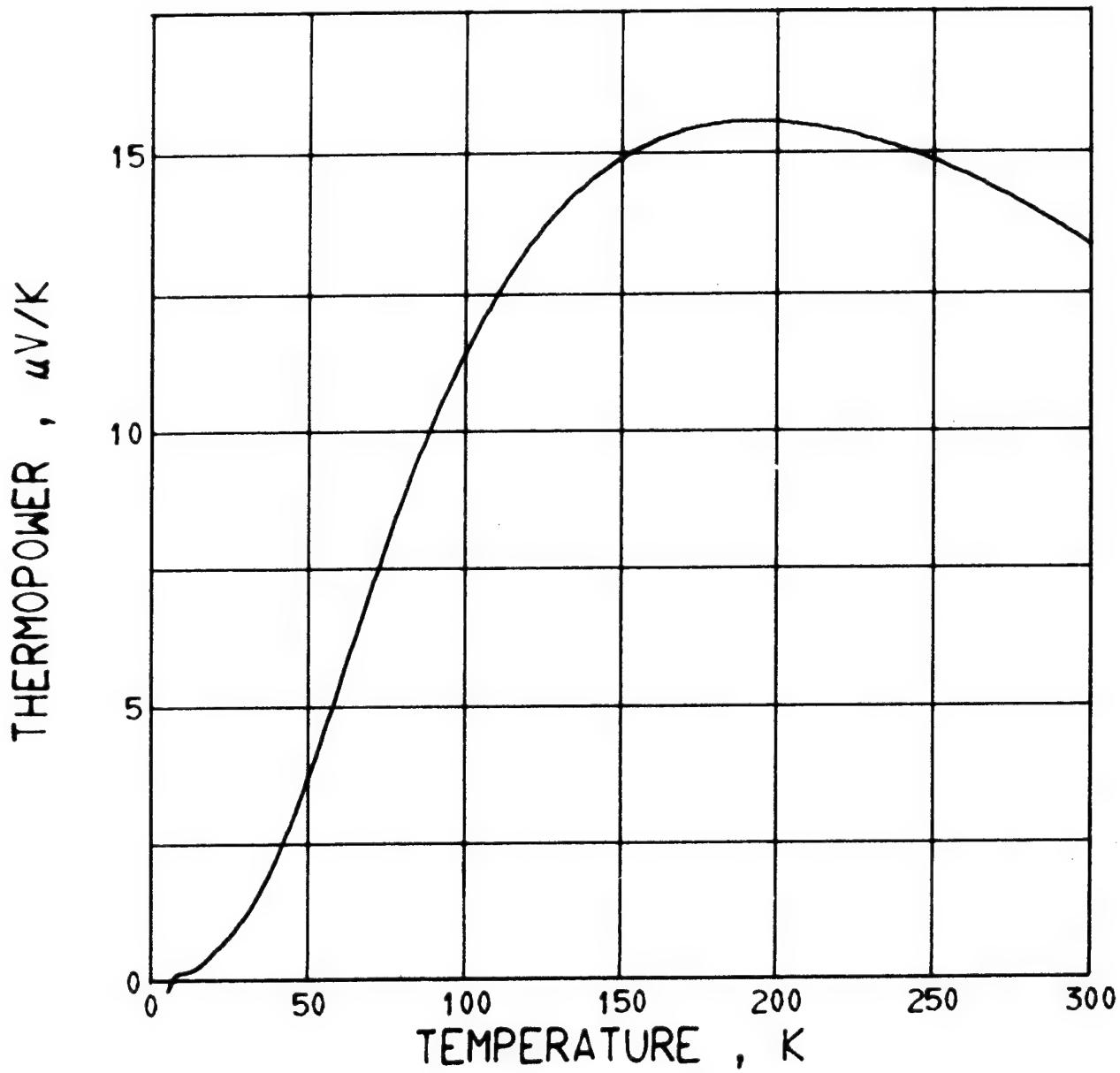


Figure 13d. Thermopower of Armco iron, specimen 4.

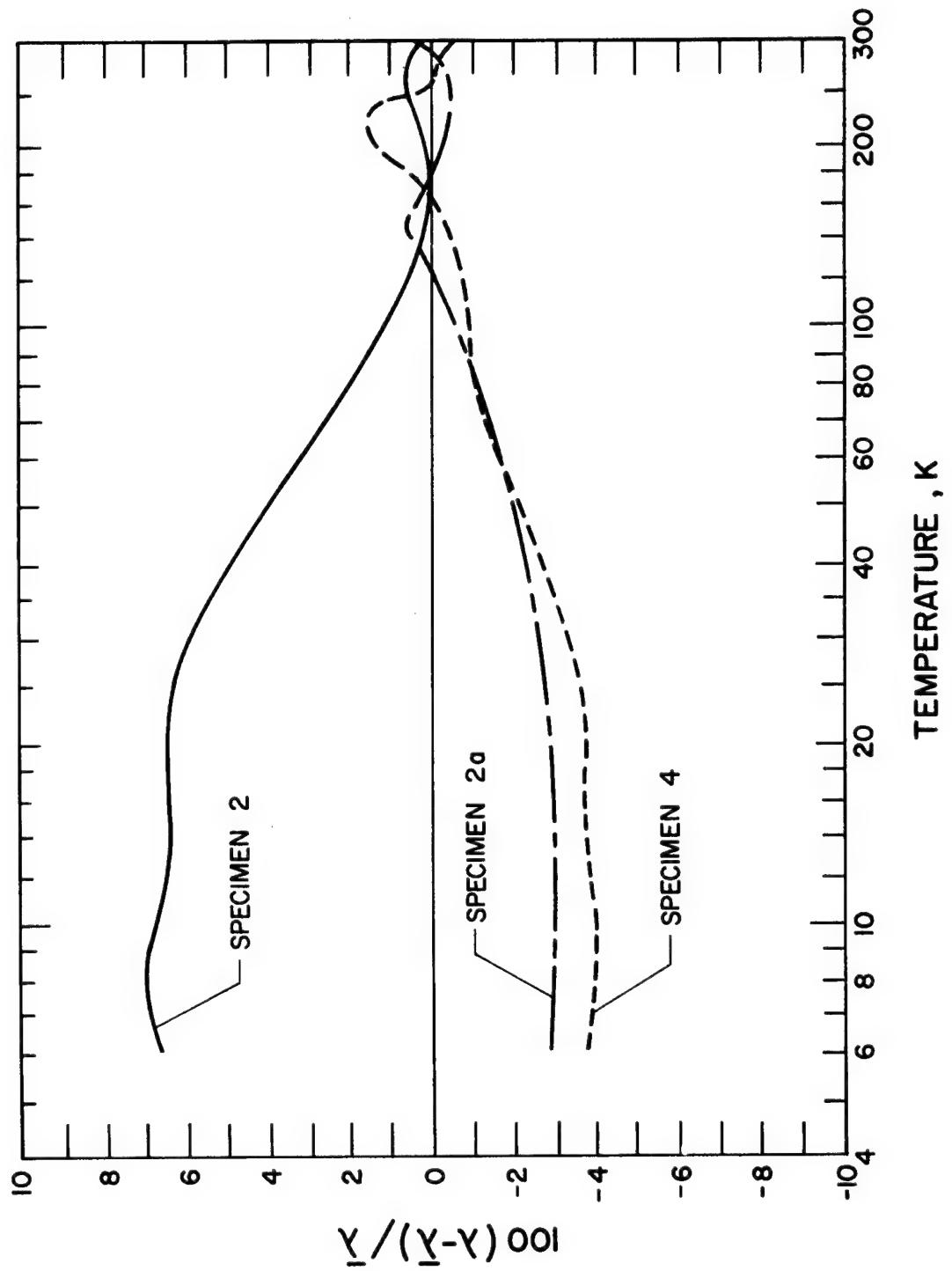


Figure 14. Deviations of the thermal conductivities of each specimen from the mean values.

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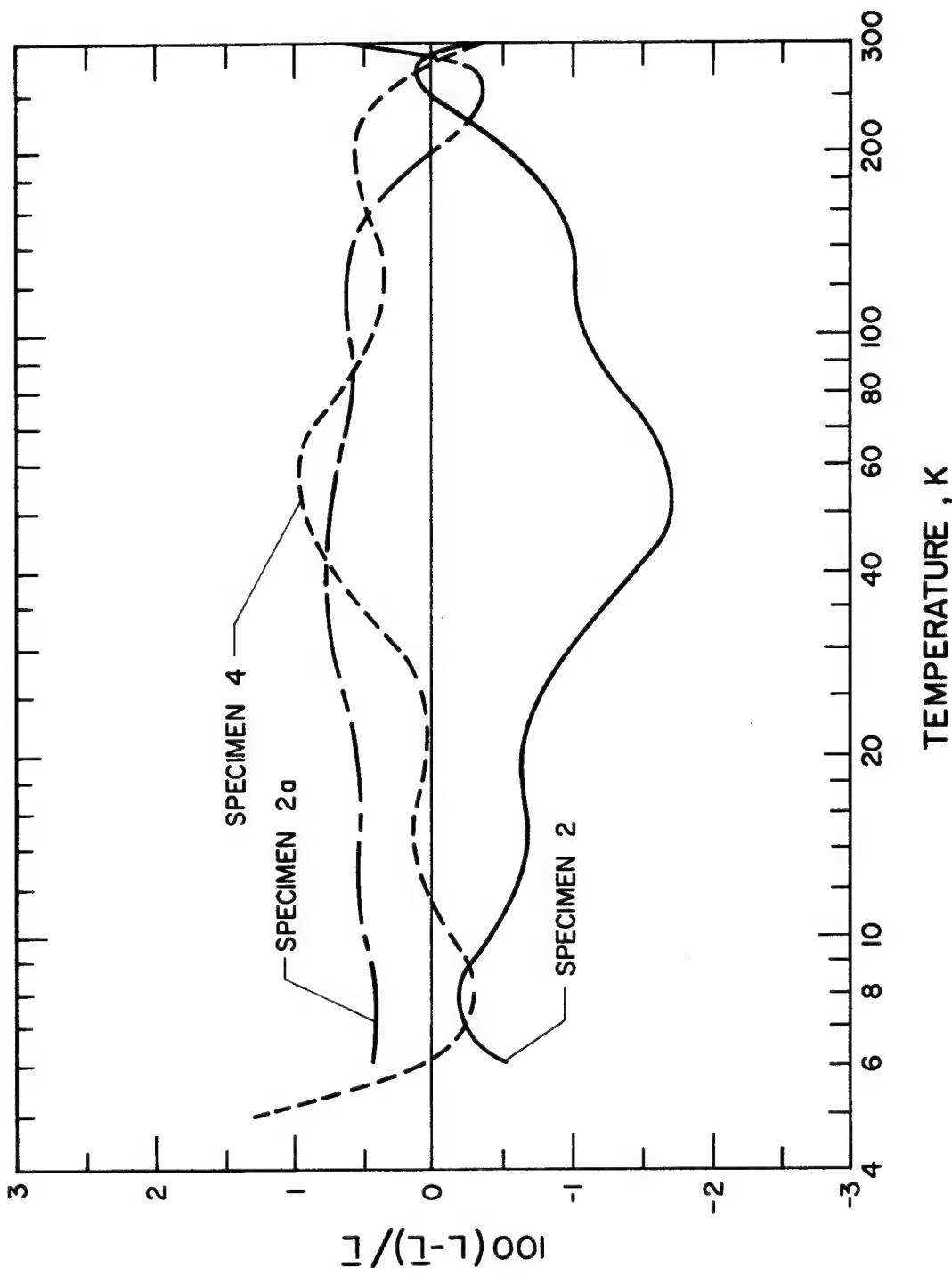


Figure 15. Deviations of the Lorenz ratios of each specimen from the mean values.

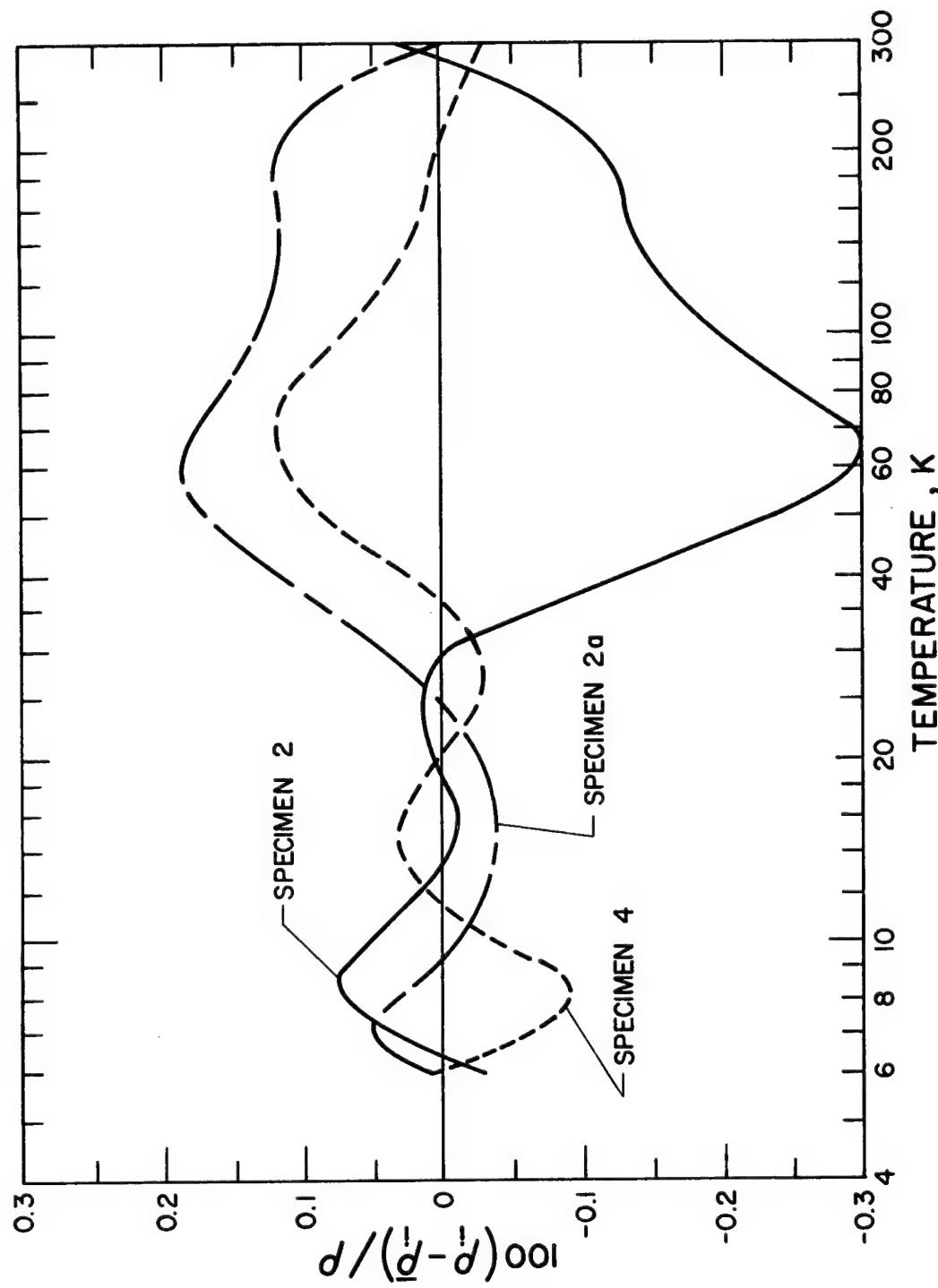


Figure 16. Deviations of the computed intrinsic electrical resistivities from the mean values for the three specimens.

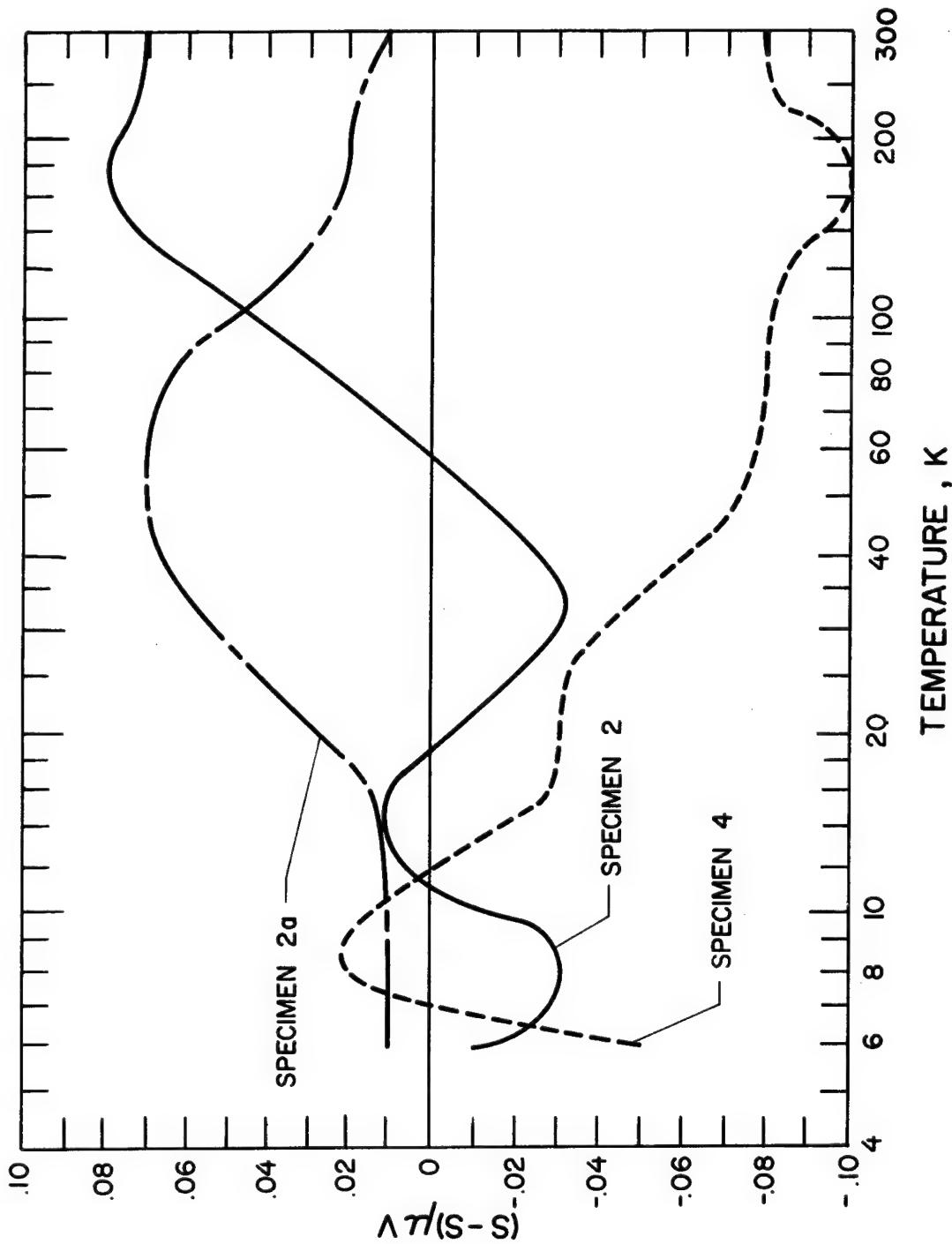


Figure 17. Deviations of the thermopowers from the mean values for three specimens of Armco iron.

B-13380

8. Appendix

A complete documentation of experimental and numerical procedures was intended to be given in a previous report (Hust, et al.^[1]) so that future manipulations with the experimental data could be performed if necessary. Some useful information, overlooked in the preparation of that report, is included here.

The calibration table for the Chromel vs Au-Fe (Au-0.07 at. % Fe) thermocouples is given in table I. The derivation of this table is explained in reference [1].

To compute the reference ring temperature from the experimental data one needs the calibration of the platinum resistance thermometer. Table II is the calibration table for the PRT used in this apparatus and designated LN-1037903.

To reanalyze any of the reported data one must have the actual thermocouple positions (nominally 2.54 cm apart) and the diameter of the specimen. Table II contains these data for the previously reported specimens as well as for Armco iron.

As reported by Hust, et al.,^[1] zero emfs were read for each thermocouple to eliminate, as much as possible, the effect of spurious emfs in the potentiometric circuitry. These zero emfs differ for each cryogenic bath and are listed in table IV.

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at.% Fe) thermocouple

T (K)	Emf (μ V)	T (K)	Emf (μ V)
		51	819.32
		52	836.35
		53	853.44
4	39.59	54	870.57
5	52.40	55	887.74
6	66.07	56	904.96
7	80.48	57	922.22
8	95.50	58	939.53
9	111.03	59	956.89
10	126.98	60	974.30
11	143.27	61	991.75
12	159.83	62	1009.24
13	176.61	63	1026.79
14	193.55	64	1044.38
15	210.61	65	1062.01
16	227.75	66	1079.70
17	244.96	67	1097.42
18	262.19	68	1115.20
19	279.44	69	1133.02
20	296.68	70	1150.88
21	313.90	71	1168.79
22	331.10	72	1186.75
23	348.26	73	1204.74
24	365.38	74	1222.79
25	382.47	75	1240.87
26	399.50	76	1259.00
27	416.50	77	1277.17
28	433.45	78	1295.39
29	450.35	79	1313.65
30	467.22	80	1331.95
31	484.05	81	1350.29
32	500.84	82	1368.67
33	517.61	83	1387.10
34	534.34	84	1405.57
35	551.05	85	1424.08
36	567.74	86	1442.63
37	584.42	87	1461.22
38	601.08	88	1479.85
39	617.74	89	1498.52
40	634.39	90	1517.23
41	651.05	91	1535.98
42	667.73	92	1554.77
43	684.44	93	1573.60
44	701.17	94	1592.46
45	717.94	95	1611.37
46	734.74	96	1630.31
47	751.58	97	1649.29
48	768.45	98	1668.31
49	785.37	99	1687.36
50	802.32	100	1706.45

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at. % Fe) thermocouple (Continued)

T (K)	Emf (μ V)	T (K)	Emf (μ V)
101	1725.58	151	2721.26
102	1744.74	152	2741.86
103	1763.94	153	2762.48
104	1783.17	154	2783.12
105	1802.44	155	2803.78
106	1821.75	156	2824.47
107	1841.08	157	2845.18
108	1860.45	158	2865.92
109	1879.86	159	2886.67
110	1899.30	160	2907.45
111	1918.77	161	2928.25
112	1938.27	162	2949.07
113	1957.80	163	2969.92
114	1977.37	164	2990.78
115	1996.97	165	3011.67
116	2016.60	166	3032.58
117	2036.26	167	3053.51
118	2055.95	168	3074.46
119	2075.67	169	3095.43
120	2095.42	170	3116.42
121	2115.20	171	3137.43
122	2135.01	172	3158.46
123	2154.85	173	3179.50
124	2174.72	174	3200.57
125	2194.61	175	3221.66
126	2214.54	176	3242.77
127	2234.49	177	3263.89
128	2254.47	178	3285.04
129	2274.48	179	3306.20
130	2294.51	180	3327.38
131	2314.57	181	3348.58
132	2334.66	182	3369.79
133	2354.78	183	3391.03
134	2374.92	184	3412.28
135	2395.09	185	3433.55
136	2415.29	186	3454.83
137	2435.51	187	3476.13
138	2455.75	188	3497.45
139	2476.03	189	3518.79
140	2496.33	190	3540.14
141	2516.65	191	3561.51
142	2537.00	192	3582.90
143	2557.38	193	3604.30
144	2577.78	194	3625.72
145	2598.20	195	3647.15
146	2618.65	196	3668.60
147	2639.12	197	3690.07
148	2659.62	198	3711.55
149	2680.15	199	3733.05
150	2700.69	200	3754.56

Table I - Calibration table for Chromel vs Au-Fe
(Au-0.07 at. % Fe) thermocouple (Continued)

T (K)	Emf (μ V)	T (K)	Emf (μ V)
201	3776.09	251	4869.70
202	3797.64	252	4891.86
203	3819.20	253	4914.03
204	3840.77	254	4936.21
205	3862.36	255	4958.40
206	3883.97	256	4980.60
207	3905.59	257	5002.80
208	3927.22	258	5025.02
209	3948.87	259	5047.24
210	3970.54	260	5069.48
211	3992.22	261	5091.72
212	4013.91	262	5113.97
213	4035.62	263	5136.22
214	4057.34	264	5158.49
215	4079.08	265	5180.76
216	4100.83	266	5203.03
217	4122.60	267	5225.31
218	4144.38	268	5247.60
219	4166.17	269	5269.89
220	4187.97	270	5292.19
221	4209.79	271	5314.49
222	4231.62	272	5336.79
223	4253.47	273	5359.10
224	4275.32	274	5381.41
225	4297.19	275	5403.73
226	4319.08	276	5426.06
227	4340.97	277	5448.40
228	4362.88	278	5470.75
229	4384.79	279	5493.12
230	4406.72	280	5515.50
231	4428.66	281	5537.90
232	4450.62	282	5560.30
233	4472.58	283	5582.69
234	4494.55	284	5605.09
235	4516.54	285	5627.49
236	4538.53	286	5649.89
237	4560.54	287	5672.29
238	4582.56	288	5694.68
239	4604.58	289	5717.08
240	4626.62	290	5739.48
241	4648.67	291	5761.88
242	4670.73	292	5784.28
243	4692.80	293	5806.67
244	4714.87	294	5829.07
245	4736.96	295	5851.47
246	4759.06	296	5873.87
247	4781.17	297	5896.27
248	4803.29	298	5918.66
249	4825.42	299	5941.06
250	4847.56	300	5963.46

Table II - Calibration table for platinum
resistance thermometer designated LN-1037903

T (K)	R (ohms)	T (K)	R (ohms)
		51	2.02192
		52	2.11806
		53	2.21540
		54	2.31385
		55	2.41334
		56	2.51381
		57	2.61520
		58	2.71745
		59	2.82051
10	0.02343	60	2.92435
11	0.02636	61	3.02891
12	0.03008	62	3.13413
13	0.03479	63	3.23997
14	0.04071	64	3.34636
15	0.04806	65	3.45326
16	0.05705	66	3.56058
17	0.06786	67	3.66829
18	0.08067	68	3.77634
19	0.09568	69	3.88468
20	0.11305	70	3.99329
21	0.13294	71	4.10213
22	0.15548	72	4.21119
23	0.18082	73	4.32046
24	0.20905	74	4.42992
25	0.24025	75	4.53954
26	0.27448	76	4.64932
27	0.31178	77	4.75925
28	0.35218	78	4.86933
29	0.39566	79	4.97954
30	0.44224	80	5.08988
31	0.49192	81	5.20035
32	0.54466	82	5.31092
33	0.60042	83	5.42157
34	0.65915	84	5.53229
35	0.72078	85	5.64307
36	0.78522	86	5.75391
37	0.85236	87	5.86480
38	0.92213	88	5.97569
39	0.99441	89	6.08654
40	1.06909	90	6.19732
41	1.14607	91	6.30805
42	1.22526	92	6.41869
43	1.30656	93	6.52925
44	1.38988	94	6.63972
45	1.47513	95	6.75011
46	1.56222	96	6.86042
47	1.65106	97	6.97064
48	1.74153	98	7.08078
49	1.83356	99	7.19083
50	1.92706	100	7.30079

Table II - Calibration table for platinum resistance thermometer designated LN-1037903 (Continued)

T (K)	R (ohms)	T (K)	R (ohms)
101	7.41069	151	12.81232
102	7.52050	152	12.91870
103	7.63023	153	13.02502
104	7.73988	154	13.13128
105	7.84945	155	13.23748
106	7.95894	156	13.34363
107	8.06836	157	13.44973
108	8.17769	158	13.55577
109	8.28695	159	13.66175
110	8.39613	160	13.76768
111	8.50524	161	13.87355
112	8.61427	162	13.97937
113	8.72322	163	14.08513
114	8.83210	164	14.19085
115	8.94091	165	14.29650
116	9.04964	166	14.40211
117	9.15830	167	14.50766
118	9.26688	168	14.61316
119	9.37539	169	14.71861
120	9.48383	170	14.82401
121	9.59220	171	14.92936
122	9.70050	172	15.03465
123	9.80873	173	15.13990
124	9.91689	174	15.24510
125	10.02497	175	15.35024
126	10.13299	176	15.45534
127	10.24094	177	15.56039
128	10.34883	178	15.66539
129	10.45664	179	15.77034
130	10.56439	180	15.87524
131	10.67207	181	15.98010
132	10.77968	182	16.08491
133	10.88723	183	16.18967
134	10.99471	184	16.29439
135	11.10213	185	16.39905
136	11.20949	186	16.50368
137	11.31677	187	16.60825
138	11.42400	188	16.71278
139	11.53116	189	16.81727
140	11.63826	190	16.92171
141	11.74530	191	17.02611
142	11.85227	192	17.13046
143	11.95918	193	17.23477
144	12.06604	194	17.33903
145	12.17283	195	17.44325
146	12.27956	196	17.54743
147	12.38623	197	17.65156
148	12.49284	198	17.75565
149	12.59939	199	17.85970
150	12.70589	200	17.96371

Table II - Calibration table for platinum resistance thermometer designated LN-1037903 (Continued)

T (K)	R (ohms)	T (K)	R (ohms)
201	18.06767	251	23.21758
202	18.17160	252	23.31969
203	18.27548	253	23.42178
204	18.37932	254	23.52383
205	18.48312	255	23.62585
206	18.58688	256	23.72784
207	18.69060	257	23.82980
208	18.79428	258	23.93172
209	18.89792	259	24.03362
210	19.00152	260	24.13548
211	19.10508	261	24.23732
212	19.20860	262	24.33912
213	19.31208	263	24.44089
214	19.41552	264	24.54263
215	19.51893	265	24.64435
216	19.62230	266	24.74603
217	19.72563	267	24.84768
218	19.82892	268	24.94930
219	19.93217	269	25.05088
220	20.03539	270	25.15245
221	20.13856	271	25.25397
222	20.24171	272	25.35547
223	20.34481	273	25.45694
224	20.44788		
225	20.55091		
226	20.65390		
227	20.75686		
228	20.85979		
229	20.96268		
230	21.06553		
231	21.16835		
232	21.27113		
233	21.37388		
234	21.47659		
235	21.57927		
236	21.68192		
237	21.78453		
238	21.88771		
239	21.98965		
240	22.09216		
241	22.19463		
242	22.29707		
243	22.39948		
244	22.50186		
245	22.60420		
246	22.70651		
247	22.80879		
248	22.91103		
249	23.01325		
250	23.11543		

Table III. Thermocouple positions and specimen diameter

A4 - 7039

Thermocouple positions (inches from floating sink)	0.87540, 1.87550, 2.87560, 3.87540, 4.87570, 5.87560, 6.87560, 7.87580
Specimen diameter (inches)	0.14499

Be

Thermocouple positions (inches from floating sink)	0.86375, 1.86380, 2.86300, 3.86365, 4.86420, 5.86385, 6.86360, 7.86265
Specimen diameter (inches)	0.14421

Hastelloy-X

Thermocouple positions (inches from floating sink)	0.87640, 1.87630, 2.87650, 3.87640, 4.87650, 5.87640, 6.87640, 7.87620
Specimen diameter (inches)	0.44432

Ti A-110 AT

Thermocouple positions (inches from floating sink)	0.87570, 1.87570, 2.87580, 3.87630, 4.87620, 5.87610, 6.87610, 7.87630
Specimen diameter (inches)	0.44425

Inconel 718

Thermocouple positions (inches from floating sink)	0.87580, 1.87580, 2.87680, 3.87590, 4.87710, 5.87710, 6.87740, 7.87740
Specimen diameter (inches)	0.44380

PO-3 graphite

Thermocouple positions (inches from floating sink)	0.87500, 1.87500, 2.87500, 3.87500, 4.87500, 5.87500, 6.87500, 7.87500
Specimen diameter (inches)	0.42400

Armco iron (2c)

Thermocouple positions (inches from floating sink)	0.87520, 1.87560, 2.87580, 3.87620, 4.87490, 5.87550, 6.87540, 7.87560
Specimen diameters (inches) [*]	0.14412, 0.14427, 0.14420, 0.14418, 0.14415, 0.14413, 0.14405

Armco iron (4c)

Thermocouple positions (inches from floating sink)	0.87720, 1.87700, 2.87740, 3.87750, 4.87690, 5.87770, 6.87780, 7.87760
Specimen diameters (inches) [*]	0.14397, 0.14393, 0.14378, 0.14368, 0.14365, 0.14368, 0.14372

* These diameters are average values between successive thermocouples starting with the end nearest the floating sink.

Table IV. Zero emfs of specimen temperature measuring thermocouples
 (Thermocouple number 1 is nearest the floating sink)

Cryogenic bath	Zero emf (μ V)							
	Thermocouple number							
	1	2	3	4	5	6	7	8
liquid helium	1.22	1.01	1.05	1.17	0.94	1.01	1.15	0.91
liquid hydrogen	0.39	0.19	0.25	0.35	0.16	0.21	0.34	0.12
liquid nitrogen	0.10	0.09	0.09	0.12	0.11	0.14	0.10	0.13
alcohol and CO ₂	0.00	0.12	0.08	0.09	0.12	0.12	0.09	0.14
ice and water	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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